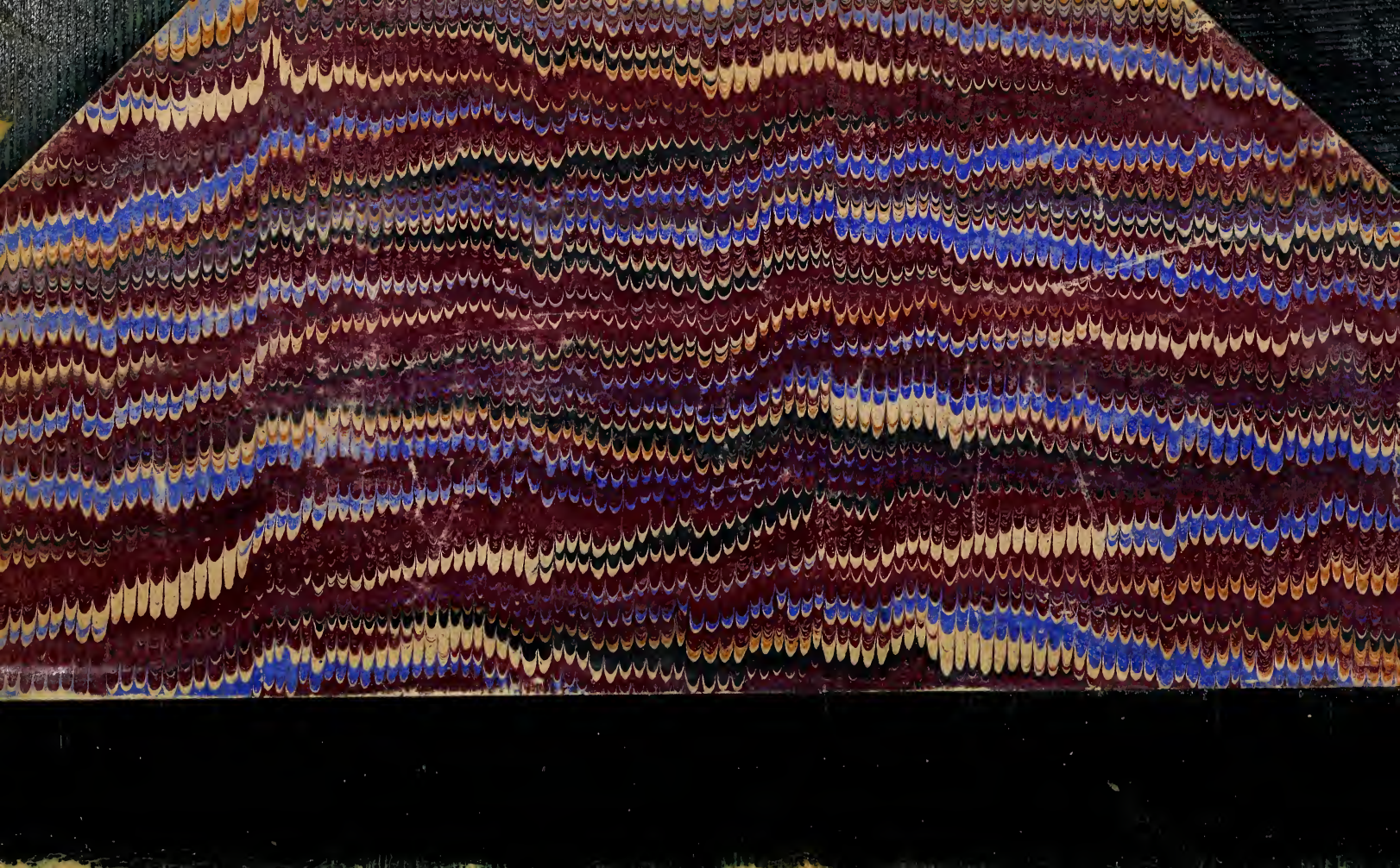

LOAVES OF BREAD, ONE MADE FROM DURUM WHEAT PATENT FLOUR, THE OTHER FROM BEST QUALITY NORTHWESTERN HARD SPRING WHEAT PATENT FLOUR.

These loaves were made at the same time, by the same bakery, and under the same conditions, the same kinds (except flour) and same proportional amounts of ingredients being used in each.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 70.
B. T. GALLOWAY, *Chief of Bureau.*

THE COMMERCIAL STATUS OF DURUM WHEAT.

BY

MARK ALFRED CARLETON,
CEREALIST IN CHARGE OF CEREAL INVESTIGATIONS.

AND

JOSEPH S. CHAMBERLAIN,
PHYSIOLOGICAL CHEMIST, CEREAL INVESTIGATIONS.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

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B. T. Galloway, *Chief.*
J. E. Rockwell, *Editor.*

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 6, 1904.

Sir: I have the honor to transmit herewith the manuscript of a paper entitled "The Commercial Status of Durum Wheat," by Mark Alfred Carleton, Cerealist in Charge of Cereal Investigations, and Dr. Joseph S. Chamberlain, Physiological Chemist, Vegetable Pathological and Physiological Investigations, and recommend its publication as Bulletin No. 70 of the series of this Bureau. The chemical investigations were conducted as a part of the cooperative work in cereal chemistry between this Bureau and the Bureau of Chemistry.

The accompanying five plates and a text figure are necessary to a complete understanding of the subject-matter of this paper.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

PREFACE.

The durum wheats are of a group quite distinct from any other wheat, and until recently their qualities were practically unknown in this country. After it had been determined that they were admirably adapted for cultivation in the semiarid districts (see Bulletin 3 of this Bureau) the demonstration of their value for various commercial purposes, particularly for making bread, became the next most important question. Numerous tests have been made by private parties, and careful experiments have been conducted by the South Dakota Agricultural Experiment Station. The Department of Agriculture has also investigated the matter, and the present publication by Messrs. Carleton and Chamberlain gives the findings of the last two years. As a result of all these inquiries the commercial standing of durum wheat may now be considered as established, thus adding a valuable industry to the resources of our country.

ERWIN F. SMITH,
Acting Pathologist and Physiologist

OFFICE OF VEGETABLE PATHOLOGICAL
AND PHYSIOLOGICAL INVESTIGATIONS,
Washington, D. C., August 4, 1904.

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THE COMMERCIAL STATUS OF DURUM WHEAT.

INTRODUCTION.

The cultivation in this country of durum wheat in response to an actual demand for it has passed the third season, and the fourth crop will soon be ready for delivery. Previous to 1901 this wheat could not usually be sold at the elevators or mills at any price and was rarely grown—in small quantities only, for stock feed. Since its commercial value has been demonstrated the production has increased from 100,000 bushels, the largest estimate in 1901, to at least 6,000,000 bushels in 1903—an increase of sixtyfold in two years. On March 18, 1904, the price of durum wheat at Buffalo, N. Y., was $1.03 per bushel, though there was practically none to be obtained. Since May 20, 1904, $1 per bushel has been offered at Buffalo for No. 2 durum wheat, to arrive on the opening of lake navigation.[a] A very good export business was accomplished with the 1903 crop, although the quality of the grain for export in that year was the worst it has ever been, or is likely to be, because of the unusually wet season. In the entire history of the country no other new crop appears to have made so remarkable a record.

PROPER RANK OF DURUM WHEAT.

It is a striking fact that 6,000,000 bushels of a grain formerly rejected should be sold at a fancy price toward the close of the winter, long before the new season opens. Most important of all, much the larger portion was sold to the mills for making bread flour. The significance of these facts is evident. The continued success of recent milling and baking operations has clearly demonstrated that durum wheat has not heretofore been given its proper rank. It should properly be considered as a wheat of the highest class, ranking with hard spring and hard winter, but should be graded on its own merits and kept absolutely distinct from either of these.

[a] It should be noted that this particular demand for durum wheat is chiefly for making bread flour at the mills.

In portions of Europe where this wheat is well known its excellent qualities have been properly recognized for a long time, as mentioned in former publications. In France, the greatest bread-eating country of the world, a large quantity of durum wheat is used for bread, and in the region from Greece to Roumania, inclusive, it forms a large percentage of the annual crop consumed. Much the largest production of durum wheat is in east and south Russia, and the price at the principal Russian markets is always higher than that of the hard red spring and winter wheats, although the latter easily equal in quality the similar wheats of this country. In the Volga River region the variety Kubanka or Beloturka, a durum wheat, is the most popular of all and always commands a price considerably higher than that of the hard red wheats, this price being the same either for local consumption or for export. The best bread of that region contains at

ПРЕЙСЪ-КУРАНТЪ № 49.

САМАРСКОЙ БИРЖИ за время съ 7 по 13 сентября 1898 года.

Было въ привозѣ:	Понедѣльникъ. Вагоновъ.	Понедѣльникъ. Возовъ.	Понедѣльникъ. Цѣна въ копѣйкахъ. от	Понедѣльникъ. Цѣна въ копѣйкахъ. до	Вторникъ. Вагоновъ.	Вторникъ. Возовъ.	Вторникъ. Цѣна въ копѣйкахъ. от	Вторникъ. Цѣна въ копѣйкахъ. до	Среда. Вагоновъ.	Среда. Возовъ.	Среда. Цѣна въ копѣйкахъ. от	Среда. Цѣна въ копѣйкахъ. до	Четвергъ. Вагоновъ.	Четвергъ. Возовъ.	Четвергъ. Цѣна въ копѣйкахъ. от	Четвергъ. Цѣна въ копѣйкахъ. до	Пятница. Вагоновъ.	Пятница. Возовъ.	Пятница. Цѣна въ копѣйкахъ. от	Пятница. Цѣна въ копѣйкахъ. до	Суббота. Вагоновъ.	Суббота. Возовъ.	Суббота. Цѣна въ копѣйкахъ. от	Суббота. Цѣна въ копѣйкахъ. до	За недѣлю. Вагоновъ.	За недѣлю. Возовъ.	За недѣлю. Цѣна за п. въ коп. от	За недѣлю. Цѣна за п. въ коп. до
Пшеницы: бѣлотурки.	—	1000	110	122	—	—	—	—	—	250	109	122	—	1200	111	123	—	2500	110	123	—	600	110	123	—	5550	109	123
„ перерода.	—	600	102	108	—	—	—	—	—	150	104	107	—	650	105	108	—	700	104	107	—	350	102	108	—	2450	102	108
„ степки .	—	400	102	109	—	—	—	—	—	100	103	110	—	350	106	110	—	300	103	111	—	150	105	111	—	1300	102	111
„ русской .	—	300	92	102	—	—	—	—	—	30	92	100	—	250	82	103	—	600	94	103	—	750	94	105	—	1930	82	103
Рожь .	—	10	70	72	—	—	—	—	18	—	70	72	11	15	70	72	—	—	71	73	—	—	—	—	29	25	70	73
Овесъ перерода .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
„ обыкновеннаго.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Сѣмя льняного .	—	30	124	123	—	—	—	—	—	—	—	—	—	30	115	130	—	—	—	—	—	—	—	—	—	60	115	130
„ подсолнечнаго .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ячменя . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Гороха . .	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

FIG. 1.—Reproduction of a portion of a bulletin of the board of trade of Samara, Russia.[a]

least 80 per cent of Kubanka wheat flour, the remainder being usually hard red spring wheat flour.

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[a] The extract here shown of this board of trade bulletin (a translation of which is given on page 11) gives the quantity of different grains received daily at this point and the daily variation in price (in kopecks) per pood. All of the kinds of wheat represented are durum except the one called Russian. It will be seen that the durum wheats not only arrive in considerably larger quantities, but command a much higher price than the variety Russian, although this latter variety corresponds well to our own northern hard spring wheats and is absolutely as good in quality. In fact, our own hard spring wheat probably originated in that region.

Price current No. 49, Samara Board of Trade, September 7–13, 1898.

Arrived.	Monday.				Tuesday.				Wednesday.				Thursday.			
	Cars.	Cartloads.	Price per pood in kopecks. From—	To—	Cars.	Cartloads.	Price per pood in kopecks. From—	To—	Cars.	Cartloads.	Price per pood in kopecks. From—	To—	Cars.	Cartloads.	Price per pood in kopecks. From—	To—
Wheat:																
Beloturka	----	1,000	110	122	----	----	-----	-----	----	250	109	122	----	1,200	111	123
Pereroda	----	600	102	108	----	----	-----	-----	----	150	104	107	----	650	105	108
Egyptian	----	400	102	109	----	----	-----	-----	----	100	103	110	----	350	106	110
Russian	----	300	92	102	----	----	-----	-----	----	30	92	100	----	250	82	103
Rye	----	10	70	72	----	----	-----	-----	18	-----	70	72	11	15	70	72
Oats:																
Pereroda	----	-----	----	----	----	----	-----	-----	----	-----	----	----	----	-----	----	----
Common	----	-----	----	----	----	----	-----	-----	----	-----	----	----	----	-----	----	----
Flaxseed	----	30	121	123	----	----	-----	-----	----	-----	----	----	----	30	115	130
Sunflower seed	----	-----	----	----	----	----	-----	-----	----	-----	----	----	----	-----	----	----
Barley	----	-----	----	----	----	----	-----	-----	----	-----	----	----	----	-----	----	----
Peas	----	-----	----	----	----	----	-----	-----	----	-----	----	----	----	-----	----	----

Arrived.	Friday.				Saturday.				Week.			
	Cars.	Cartloads.	Price per pood in kopecks. From—	To—	Cars.	Cartloads.	Price per pood in kopecks. From—	To—	Cars.	Cartloads.	Price per pood in kopecks. From—	To—
Wheat:												
Beloturka	----	2,500	110	123	----	600	110	123	------	5,550	109	123
Pereroda	----	700	104	107	----	350	102	108	------	2,450	102	108
Egyptian	----	300	103	111	----	150	105	111	------	1,300	102	111
Russian	----	600	94	103	----	750	94	103	------	1,930	82	103
Rye	----	-----	71	73	----	-----	-----	-----	29	25	70	73
Oats:												
Pereroda	----	-----	-----	-----	----	-----	-----	-----	------	-----	-----	-----
Common	----	-----	-----	-----	----	-----	-----	-----	------	-----	-----	-----
Flaxseed	----	-----	-----	-----	----	-----	-----	-----	------	60	115	130
Sunflower seed	----	-----	-----	-----	----	-----	-----	-----	------	-----	-----	-----
Barley	----	-----	-----	-----	----	-----	-----	-----	------	-----	-----	-----
Peas	----	-----	-----	-----	----	-----	-----	-----	------	-----	-----	-----

The city of Samara, on the upper Volga, having a population of about 100,000, although not particularly a milling center, corresponds fairly well in other respects to Minneapolis as a grain market. At this place a variety called simply "Russian" is the chief representative of the hard spring wheats, while the durum wheat group is represented by Kubanka. A photographic reproduction of a portion of the daily bulletin of the Samara board of trade is shown in figure 1, followed by a translation of the same, which illustrates the superior value of Kubanka wheat at this place. It will be seen that from September 19 to 25, 1898, the price of Kubanka ranged from 109 to 123 kopecks (1 kopeck equals 0.515 cent) per pood (36 pounds), and that Russian sold at 82 to 103 kopecks. The number of cartloads of Kubanka received during the week was 5,550, while 1,930 cartloads of Russian were received during the same time.[a] It is interesting to note that

[a] A cartload ordinarily averages 42 bushels. This was a famine year in east Russia; hence the grain receipts at Samara were unusually low.

just five years later almost an exact reverse of the relations in price of these two classes of wheat existed in this country, at Minneapolis, and yet we have the same system of milling and largely the same export outlet for our wheat and flour as Russia. The explanation is that the American trade is only now becoming acquainted with durum wheat.

SPECIAL QUALITIES OF COMMERCIAL VALUE.

So long as durum wheat is grown where it is well adapted, it will always possess certain special qualities of commercial value not existing to so great a degree in other wheats: (1) In the strictly semiarid districts it usually ripens earlier than other spring wheats. This allows the wheat a greater chance to escape insect and fungous pests and thus insures a plumper, finer kernel. (2) Freedom from rust and smut is still further insured by the natural resistance of this wheat to the attacks of such fungi. The importance of smut resistance in the fields of the Northwest is manifest to those who are aware of the great damage to wheat from this cause in that region. (3) Hard spring and winter wheats are known to produce a harder, better grain in the drier districts and in dry seasons. Durum wheat, being particularly adapted to such conditions, always furnishes an excellent hard grain without a corresponding decrease in yield. (4) Accompanying this drought resistance and hardness of grain is a corresponding increase in the quantity and quality of the gluten.[a] (5) In the analyses of flour and bread, given on another page, it is shown that the sugar content of durum wheat is considerably greater than that of other wheats. Even a small percentage of difference in this respect is of great importance to the baker during a year's operations. (6) The extreme dryness of the durum wheat grain in a good season[b] gives the flour a great power of absorption, which, other conditions being equal, allows the baker to obtain more loaves from the same weight of flour, and in some cases would thus give this wheat a great advantage over other wheat flours of less absorption.

THE NAME "DURUM."

Durum wheat is generally known in this country as macaroni wheat. It is now a matter of regret that this name was used. It was first employed in publications of this Department, chiefly because of the fact that no other wheat will make first-class macaroni. It was

[a] The results of experiments with different flours, discussed elsewhere in this bulletin, do not show any particular superiority for this wheat over others in this respect, but, as there explained, the flours examined were those of wet seasons, which are especially injurious to durum wheat.

[b] It should be explained that a good season for durum wheat may be a poor one for ordinary wheat. Within extreme limits the drier the season the better it is for this wheat, while unusual moisture, especially great humidity, is very disastrous.

deemed sufficient at first to establish its commercial value on this basis alone, and its use for bread was not then urged by the Department. The results of milling and baking operations of the last two years, however, have so changed the status of the wheat that it now seems quite desirable to discard the name "macaroni," for the following reasons: (1) It is quite misleading, as durum wheat is now known to make excellent bread as well as macaroni; and (2) it is not a general name; in fact, is not used outside of this country, except very recently in Canada and Australia. It is therefore recommended and urged that grain dealers, inspectors, and all others concerned use the name "durum" instead of "macaroni." The word "durum" means *hard*, and is therefore very appropriate, and it is universally known. Many farmers will no doubt persist in using the name "macaroni," but the name "durum" will usually be understood by them. For a time the name "macaroni" might be used parenthetically until the name "durum" becomes more familiar.

DURUM WHEAT FOR MACARONI.

While the durum wheat can not be correctly considered as simply a macaroni wheat, yet it should be kept in mind that no other wheat, except perhaps Polish, will make good macaroni. There are two chief reasons why Americans do not eat several times as much macaroni as at present: (1) It is usually not made from the proper kind of wheat and (2) it is rarely prepared properly in the kitchen. The former is probably the more important reason. It is as easy to make typical Minneapolis flour from California wheat as it is to make first-class macaroni from other than durum wheat. It is a common error to suppose that the excellence of Italian macaroni is due simply to the methods of manufacture employed by Italians. The real reason for this excellence is that only durum wheat is used, though it is true that the methods employed are occasionally superior to those of many American factories.

CHARACTERISTICS OF GOOD MACARONI.

The principal characteristics of good macaroni and those which distinguish a product of true durum wheat from that which is made from ordinary wheat are as follows: (1) It must have a rich yellow color, at the same time without any application of artificial coloring matter; (2) it must be translucent or almost transparent; (3) the sticks should permit of considerable bending without breaking; (4) the macaroni should be able to retain its firmness after at least twenty minutes in boiling water; (5) when served at the table it should not be flabby nor pasty; (6) it should not be soft and doughy when eaten, but should remain firm in consistency. Of course, the attainment of these qualities will depend to some extent upon the methods of manufacture of either the semolina or the macaroni, or both, but it is always mainly

dependent upon the kind of wheat employed. As all food grains contain an abundance of starch, the comparative nutritive value of different kinds of macaroni or of macaroni made from different kinds of wheat will depend chiefly upon the proteid content; but, as in the case of bread making, it must be remembered that the quality as well as the quantity of gluten is of great importance.

The following series of analyses made by the Bureau of Chemistry of this Department will give some information on the comparative percentage of proteids in macaroni from different wheats. It will be seen that the highest percentage of proteid is found in the macaroni produced from durum wheat.

TABLE 1.—*Analyses of macaroni produced from different wheats; results expressed as percentages.*

Number.	Name of product.	Kind of wheat from which made.	Moisture.	Fat.	Crude fiber.	Ash.	Proteids.	Carbohydrates by difference.
1	Egg noodles	Hard spring (with eggs)	9.27	4.36	0.31	0.71	15.63	69.72
2	Spaghetti	Common wheat, kind unknown.	9.55	.47	.71	.57	12.63	76.06
3	Macaroni	do	10.20	.38	.52	.61	12.31	75.98
4	do	Kansas hard winter	10.36	.38	.57	.51	12.06	76.12
5	do	Dakota and Minnesota	10.24	.43	.37	.43	11.06	77.47
6	Spaghetti	do	10.15	.44	.37	.44	12.63	75.97
7	Mezzani	Minnesota spring	10.20	.22	.38	.32	12.56	76.32
8	Macaroni	Hard common wheat	10.19	.42	.37	.43	13.88	74.71
9	Spaghetti	Hard spring	10.15	.19	.40	.56	13.44	75.26
10	do	Kansas hard winter	10.06	.56	.35	.47	12.56	76.00
11	Macaroni	do	10.06	.46	.49	.45	12.63	75.91
12	Macaroni (artificially colored).	Hard spring	9.44	.26	.46	.67	13.25	75.92
13	Macaroni	Mixed hard and soft common wheat.	9.58	.19	.53	.83	14.75	74.92
14	do	Mixed Kansas hard and ordinary winter.	9.79	.49	.38	.63	12.63	76.08
15	Macaroni (splits easily).	do	10.00	.40	.37	.62	12.75	75.86
16	Macaroni (very large).	Hard common wheat	9.73	.45	.38	.48	14.06	74.90
17	Macaroni (genuine Italian imported).	Unknown	10.05	.24	.50	.65	13.06	75.50
18	Macaroni	Grown to order	9.91	.49	.39	.44	12.06	76.71
19	do	Pillsbury's best flour	9.61	.58	.38	.43	13.81	75.19
20	do	True durum wheat grown to order.	10.50	.75	.22	.50	17.13	70.90
21	Mezzani	Imported Taganrog durum.	10.25	.58	.22	.64	10.19	78.12
22	Macaroni	Best Minnesota spring	10.29	.67	.23	.43	12.38	76.00
23	Macaroni (genuine French imported).	Unknown	10.02	.39	.25	.71	12.25	76.38
24	Mezzani (genuine Italian imported).	American mixed durum and common wheat.	10.88	.41	.23	.53	11.50	76.43
25	Macaroni	Common wheat, kind unknown.	11.88	.40	.27	.52	10.06	76.87

PROCESS OF MANUFACTURE.

Though the kind of wheat employed is by far of the greatest importance, yet the process of manufacture in most of the factories of this country is very unsatisfactory, and there is no doubt that very much better results would be obtained by the employment of better methods. There are, of course, two processes, viz, (1) the manufacture of the semolina and (2) the making of the macaroni, and it is important

that proper methods should be employed in each case. The chief defect in American methods is in the manufacture of the semolina, and this consists mainly in very imperfect operations with the bolting cloth. Several of the finer products should be screened out and the particular grade of semolina intended for macaroni should be very much coarser than is ordinarily furnished by the mills; in fact, the production of a proper grade of semolina, now that the proper wheat is in cultivation, is practically the only requisite in this country for the production of the very best macaroni that can be made. It must be said that several of the millers of this country have spent much time and money in an endeavor to improve their milling operations in this respect, and have already made considerable progress. The reader is referred to Bulletin No. 20 of the Bureau of Plant Industry, entitled "Manufacture of Semolina and Macaroni," for detailed descriptions of proper methods of manufacture of both semolina and macaroni. It is, of course, to be expected that in time, when very much more of the durum wheat shall be employed, milling operations will become much more perfect.

It has been affirmed in recent years and it is the general supposition that the consumption of macaroni in this country has considerably increased. It would be of much interest to learn the actual facts bearing on this question; but the statistics of the census are furnished only every ten years, and it is now necessary to wait for another census before it can be determined whether there has been any increase in the last few years, since the last census covered the production of 1899. The Treasury statistics on the importation of foreign macaroni are available every year, and of course these figures, added to our own yearly production, would give practically the total consumption in this country, as there is very little export.

By the courtesy of the Bureau of the Census of the Department of Commerce and Labor special unpublished sheets have been furnished from which approximate statistics on the production of macaroni in 1899 have been compiled. The entire production for that year of the factories which returned reports to the Bureau was 15,193,774 pounds, having a wholesale value at the warehouse where produced of $1,494,272. It is known to the Department of Agriculture that three or four of the largest factories in the United States made no returns. Several others, of course, may not have reported, but probably very few. The figures above given are therefore minimum figures, but the correct amount in each case would probably not be very much more.

As it will no doubt be a matter of considerable interest commercially, it is thought well to publish a list of all the macaroni factories in the United States so far known to this Department. This list follows, with the addresses of the factories. There are possibly a half dozen or more factories not included in the list, but it is probably fairly complete.

LIST OF MANUFACTURERS OF MACARONI IN THE UNITED STATES.

CALIFORNIA.

Los Angeles:
- California Macaroni Company, 230 Aliso street.
- Kahn-Beck Company, 467 Aliso street.

Oakland:
- Swiss-Italian Paste Company, 513 Fifth street.

Sacramento:
- Foppiani & Co., 1115 Second street.

San Francisco:
- Arata Bros., 325 Broadway.
- California Italian Paste Company, 347 Sacramento street.
- Celli, John B., 8 Margaret place.
- Columbus Paste Company, 425 Jackson street.
- Cuneo Bros., 511 Green street.
- Landucci & Co., 1423 Kearney street.
- Martinoni & Podesta, 512–514 Washington street.
- Matteucci, F., & Co., 411-413 Francisco street.
- Musto, C. E., & Co., 705-707 Battery street.
- Nunziato, L., 415 Broadway.
- Paravagna, Giacoma. 1 Vulcan lane.
- San Francisco Paste Company, 704 Sansome street.
- Smario & Grego, 810 Battery street.
- Sosso, Henry G., 1313 Dupont street.
- Splivalo, C. R., & Co., 307 Battery street.
- Valente, Luigi, 214 Broadway.

San Jose:
- Baiocchi, M., & Co.
- Prola, J.
- Ravenna Paste Company.
- San Jose Italian Paste Company.

COLORADO.

Denver:
- Mazza, F., & Co., 327 Gerspach avenue.
- Western Union Macaroni Manufacturing Company, 3654–3658 Bell street, corner West Thirty-seventh avenue.

Starkville:
- Scavarda Paste and Sausage Factory.

Trinidad:
- Casa, Joseph.

DELAWARE.

Wilmington:
- Union Macaroni Company, 209 East Fifth street.

ILLINOIS.

Chicago:
- Canepa, John B.
- Meyers Brothers Macaroni Company (new).
- National Macaroni Company, 36 La Salle street.

Braidwood:
- Rossi, Peter.

INDIAN TERRITORY

South McAlester:
- Fassino Brothers.

IOWA.

Davenport:
Crescent Macaroni Company, corner Fifth and Iowa streets.

LOUISIANA.

New Orleans:
Bertoleti, Dominick, 1200 Chartres street.
Cusimano, J., 619 St. Philip street.
Federico, L., & Bro., 1000 Chartres street.
Gensler, Philip, 520 Conti street.
Guercio, S., & Co., 310 Rampart street.
Impastato, Giuseppe, 610 Dumaine street.
Impastato, V., & Co. (Limited), 400 Magazine street.
Mathes, Louis, & Co., 1739 St. Charles avenue.
Messina, S., Macaroni Manufacturing Company (new).
Peres, Francois, 521 St. Louis street.
Sambola Italian Paste Factory (Limited), 662 St. Peter's street.
Spicuzza & Valenti, 727 Ursuline street.
Torre, J., & Bro., 429 Decatur street.

MARYLAND.

Baltimore:
Nocitra, L., & Co., 516 Ensor street.

MASSACHUSETTS.

Boston:
Ficino & Lairdino, 21 Chatham street.
Hayes, James A., & Co., 9–11 Commercial street.
Jannini, Cresenzio & Co., 191 Maverick street.
Terrile, P., 282 Commercial street.
Vesce & Capodilupo, 317 North street.

MICHIGAN.

Detroit:
Marvelli Company, The, 115 Larned street West.
Pontiac-Peninsula Macaroni Company (new).
Schmid, A. J., 407 Elmwood avenue.

MINNESOTA.

Minneapolis:
Minneapolis Macaroni Factory, 56 Central avenue.
St. Paul:
Minnesota Macaroni Company, 42 East Isabel street.
Vermicelli and Macaroni Company, The.

MISSOURI.

Kansas City:
Baker Manufacturing Company, 528 Walnut street.
Gargotta, Joseph, & Son, 500 East Third street.
St. Louis:
Capnano, Damiano, 923 North Eighth street.
Catanzaro, Joseph, 924 North Eighth street.
Gandolfo-Ghio Manufacturing Company, 104 South Eighth street.
Kappes, Erwin, 814 Julia street.
Maull, Chas., Macaroni Company, 7 North Second street.
Stobie Cereal Mills, 711 North Second street.

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MONTANA.

Butte:
Imperial Paste Manufacturing and Mercantile Company.

NEW JERSEY.

Jersey City:
Mueller, C. F., & Co., 93 Boyd avenue.
Newark:
Fello, Roffalbe, 130 Seventh avenue.
Geroot, Michael, 127 Seventh avenue.
Maulano, Francesco, 45 Sheffield street.
Sapniolo, Vincenzo, 23 Adams street.
Vineland:
D'Ippolito, G. B., 620 Cherry street.

NEW YORK.

Brooklyn:
Castruccio, A., & Sons, 66 Sackett street.
Romeo, F., & Co., 25–27 Carroll street.
Savarese, V., & Bros., 50 Irving street.
Zerega's Sons, A., 61 Front street.
Buffalo:
Amigona, Nicholas, 163 Main street.
Antoniazzi, Charles, 161 Seneca street.
Buffalo Macaroni and Vermicelli Works, 137 Broadway.
Carmelo, Manzella, 243 Court street.
Catalano, Pietro, 32 State street.
Guarina, Frank, 280 Terrace street.
Gugino Brothers, 107 Wilkeson street.
Onetto, Louis, 137 Broadway.
New York:
Atlantic Macaroni Company, West Twenty-first street, between Tenth and Eleventh avenues.
Columbia Importing and Manufacturing Company, 138 Jane street.
Goodman, A., & Sons, 638 East Seventeenth street.
Syracuse:
Hotaling-Warner Company, The, 419 Tracy street.
Utica:
Central Macaroni Company.
Italian Macaroni Company.

OHIO.

Chardon:
Chardon Macaroni Company.
Cincinnati:
Foulds Milling Company, 1225 Budd street.
German and American Pure Food Company, 1404 Walnut street.
Routspohler, A. H., Company, 114 West Court street.
Schwinn, J. S., Company, 1540 Race street.
Wuerdemann Company, The, 431 East Pearl street.
Cleveland:
Cleveland Macaroni Company, The, 1 Shaw street.
Catalano, Maria C., 15 Scovill avenue.
De Nicola & Co., 66 Hill street.
Di Franco, Antonio, 44 Erandon street.
French Delicacy Company, 58 Frankfort street.

Cleveland—Continued.
Geracio, Gaetano, 124 Woodland avenue.
Pfaffman Egg Noodle Company, 278 Seneca street.
Russo, G., & Co., 94 Coltman street.
Columbus:
Ingram, W. H., 176 King avenue.
Youngstown:
Youngstown Macaroni Company, 102 South Watts street.

OREGON.

Portland:
Colombo Paste Company.
Pacific Coast Biscuit Company.

PENNSYLVANIA.

Carnegie:
Bisi, Ernesto.
Philadelphia:
Ackerman, Rudolph, 1361 Germantown avenue.
Cini & Tasca, 933 South Tenth street.
Cuneo, Frank, 801 Christiana street.
De Angelis, R., & Co., 915 South Seventh street.
De Cecco, Giuseppe, 4392 Germantown avenue.
Di Guglielmo, Louis, 804 South Sixth street.
Di Napoli, Antonio, 741 South Seventh street.
Guano & Raggio, 924 South Seventh street.
Italian Steam Manufacturing Company, 1021 South Ninth street.
Krumm, A. C., & Son, 1012 Dakota street.
Laufer, Anton, 2333 North Second street.
Mamarella, Gaetano, 1205 South Ninth street.
Pataneo, Peter, 725 Carpenter street.
Ricchezza & Verna, 1021 South Ninth street and 804 Kimball street.
Sassa, Joseph, 812 Carpenter street.
Pittsburg:
Piccardo, B., 185 Forty-first street.
Plumfield, Marecial, 4520 Laurel street.
Scranton:
Cassesse Brothers, 99 Lackawanna avenue.

TENNESSEE.

Memphis:
De Marchi, Victor, 93 Main street.

TEXAS.

Dallas:
Carlisi & Taibbi, 258–262 Live Oak street.
Dallas Grand Macaroni Factory.
Galveston:
Texas Star Macaroni Factory, G. Martinelli & Co., 2014 Twenty-eighth street.
Houston:
Houston Macaroni Company, F. Bonno & Bro., 114 Preston avenue.
Manno, Fran, 516 Milam street.
San Antonio:
Battaglia & Co.
Mesa, F., 106 Hessler street.
Saladino, A., 228 Salinas street.
San Antonio Paste Works.

WASHINGTON.

Seattle:

Ghiglione, A. F., & Sons, 2318 First avenue.

Tacoma:

Martinolich, J. C., North Thirty-second street, between Oakes and Pine streets.

WISCONSIN.

Milwaukee:

Lorenz Brothers Macaroni Company.

POSSIBILITY OF EXPORT OF SEMOLINA AND MACARONI.

The amount of macaroni imported into the United States averages somewhere near 18,000,000 pounds per annum. Comparing this with the minimum figures on domestic production previously given, it is seen that our annual production of macaroni is very nearly the same as our annual import. A fancy price is nearly always paid for the imported macaroni, and yet the domestic macaroni should be just as good when made from the proper wheat. There is often, it is true, a lack of proper methods of manufacture of the semolina, but, as before stated, several American mills are already making rapid progress in that regard. Given, therefore, a large production of the durum wheat there is every prospect of a future production of macaroni at least equal to the home demand, and probably a sufficient quantity for a good export trade before many years have passed.

The United States has a large export flour trade, and there is apparently no good reason why there should not also be a good export trade in macaroni. But the commercial value of the wheat is of course not limited to the mere manufacture of macaroni. The macaroni manufacturer stands in the same relation to the semolina manufacturer as that borne by the baker toward the miller. An export trade to correspond with that of bread flour should therefore be an export of semolina rather than of macaroni. The semolina manufacturers of France, who furnish a large proportion of the semolina for European macaroni, are obliged very largely to import their wheat. The mills of this country would therefore have the advantage in that respect, at least over the French semolina millers, and ought to be able to compete very sharply with the French mills in supplying the numerous macaroni factories of Italy with semolina.

METHODS OF COOKING AND SERVING MACARONI.

It is a common experience that while macaroni is often mentioned on hotel bills of fare, a large percentage of the guests of these hotels seldom taste it. As has already been stated, one of the reasons for this condition is the general ignorance throughout this country of the proper methods of preparing and serving macaroni. The most common form in which macaroni is served in this country is a very white, pasty, doughy mass of the sticks, served in dilute tomato sauce. The most enthusiastic lover of macaroni would have very little if any-

thing to do with a dish of that kind. Of course it is likely to be served in a little better condition on the tables of private families, but even then there is rarely much variation in preparation from the method above described. It is little wonder, therefore, if there are very few converts from year to year to the use of macaroni as a food in their own homes.

There are of course numerous methods of preparing macaroni for the table, just as in the case of the preparation of any other food, but there is no doubt whatever that many of the very best methods are wholly unknown to most Americans. Naturally many of these methods are only used in foreign countries, where macaroni is a much more common food than in the United States. Many recipes, however, are to be found in the best cookbooks of this country, which, if widely followed, would at once give an impetus to the use of this food by the American people.

With the hope of helping to make macaroni a much more attractive food and of inducing the people to eat it much more generally, there are reproduced here from various sources a number of selected recipes for preparing this food, which seem to be the best or among the best out of several hundred that have been as carefully investigated as possible.[a]

In order to make the list of recipes more convenient for reference it is classified rather roughly under the headings, viz, semolina, soups, macaroni with cheese or milk, macaroni with tomatoes, macaroni with meats, macaroni with nuts, timbales, croquettes, garnitures, spaghetti, salads, desserts, special Italian recipes, and miscellaneous. One notes at once the interesting fact that several palatable dishes may be prepared from the semolina itself, and as true semolina produced from durum wheat has not heretofore been made in this country (and is not even now produced to perfection) and has never been imported, these will prove to be practically new dishes. Noodles is, in a way, a kind of macaroni, but being more commonly known and so often made from various kinds of flour, even the finest of patent flour, dishes prepared from noodles are not included in these recipes.

RECIPES.

SEMOLINA.

Semolina fritters.—Boil in a stewpan 1 pint of milk with 3 ounces of sugar; as soon as it boils add 6 ounces of semolina; stir until it thickens; let it cook 7 or 8

[a]Aside from other sources, in selecting these recipes the chief authorities consulted are as follows, viz: Collections of recipes by the Foulds Milling Company, the Minnesota Macaroni Company, and the Marvelli Macaroni Company; French Cookery for English Homes, compiled by Wm. Blackwood & Sons; Mrs. Lambert's Guide for Nut Cookery; Marion Harland's Complete Cookbook; Gesine Lemcke's European and American Cuisine; Déliée's Franco-American Cookery Book, and Francatelli's Modern Cook.

minutes. Remove the stewpan from the fire; put in a piece of butter the size of an egg, 3 yolks of eggs, 1 whole egg, the chopped rind of a lemon or orange, a handful of currants, and a liquor glass of kirsch. Pour this paste on a cake tin which has been moistened with water; spread the paste to the thickness of ½ inch. When it is cold divide it into squares, or in rounds, with a paste cutter; pass these through 2 beaten eggs, then into bread crumbs, and plunge them in boiling fat until they take a good color.

Cold semolina pudding.—Boil 1 quart of milk with a piece of thin lemon rind (the rind must be cut so thin that not a morsel of the white underskin attaches to it), 3½ ounces of sugar, a grain of salt, and 2 ounces of fresh butter. As soon as it boils sprinkle into it 3½ ounces of semolina, stirring all the time with a wooden spoon. When it has boiled 2 minutes draw it on one side of the stove and let it simmer for 7 or 8 minutes. In the interval, moisten the inside of a mold with cold water (a salad bowl will do as well as a mold); pour in the semolina after having taken out the lemon rind. This pudding is eaten cold, and is best with gooseberry sauce, but any fruit sirup can be served with it.

Gooseberry sauce for the above.—Put in a stewpan 1 pound of ripe red gooseberries; crush them. When they boil pass them through a hair sieve. Boil the liquid 2 or 3 minutes with 3½ ounces of white crushed sugar and a wineglassful of water. Let it get cold.

Semolina soufflé.—Boil 1 pint of milk with ¼ pound of vanilla sugar and a grain of salt. When it boils drop in gradually 1½ ounces of fine semolina, stirring continually with a wooden spoon; let it cook for 8 or 10 minutes; add 1½ ounces of fresh butter. Pour the mixture into a basin; mix it with 5 yolks of eggs. Beat up the 5 whites to a firm froth; add them gently to the semolina. Pour all into a mold which has been buttered; bake for 25 minutes in the oven. Serve sprinkled with powdered sugar.

Semolina soup.—Throw 3½ ounces of semolina into 2½ quarts of boiling soup, stirring all the time. Semolina should be thrown in like falling rain. Let all cook 15 minutes. Serve with grated cheese.

Thick semolina soup.—Prepare the soup exactly as above; then beat up the yolks of 2 eggs with 1 teacupful of cream; add little by little to the warm soup; serve at once.

Croquettes of semolina.—Boil a quart of white broth with salt and an ounce of butter; drop gently about 12 ounces of semolina, stirring all the time; stir 5 minutes longer; add 4 egg yolks and turn into a small buttered dish to cool; divide in about a dozen oblong pieces; sprinkle with dry crumbs; dip in beaten eggs and roll in fresh crumbs; fry to a nice color and serve on a folded napkin.

SOUPS.

Macaroni soup.—To 1 quart of stock brought to a boil add ¼ pound boiled macaroni cut into fine pieces; season with salt and pepper and pour into a tureen.

Vermicelli soup.—Bring to a boiling point 2 quarts of soup stock; add 4 ounces of vermicelli and boil hard for 20 minutes; season with pepper and salt and serve at once.

Macaroni soup.—Cook 1 ounce of macaroni in boiling water for 20 minutes; drain and cut into little rings; bring 1 quart of stock to the boiling point; add the macaroni and let simmer for 5 minutes; salt and pepper to taste.

Macaroni à la Calabraise.—Take 8 ripe tomatoes, press the water out and chop them fine; melt in a saucepan 2 ounces of butter, with a chopped onion and 4 ounces of finely sliced raw ham; fry slightly brown; add the tomatoes, a clove of garlic, pepper, and a bunch of parsley; fry a little longer; moisten with half a pint each of Espagnole or brown sauce (or any good meat sauce that may be more con-

venient) and beef broth; boil 15 minutes and strain with pressure through a sieve; boil half a pound of macaroni in salted water for 20 minutes; drain; put in a saucepan with 4 ounces of butter in small bits, pepper, and nutmeg; mix well; put by layers in a large bowl or deep buttered dish, alternating each layer with grated Parmesan cheese and sauce, finishing with cheese and 3 ounces of very hot, clarified, and nearly browned butter poured over; serve with 2 quarts of rich beef broth separately in a soup tureen.

MACARONI WITH CHEESE OR MILK.

Boiled macaroni and cheese.—Boil a quarter of a pound of macaroni until it is tender, but not broken; drain off the water and cover the saucepan to let it dry; boil together 1 pint of sweet milk with half a pint of rich cream; cream together 1 teaspoonful of flour with a tablespoonful of butter and add to the boiling milk, stirring constantly until it thickens; add a teaspoonful of mixed mustard; put in a deep dish alternate layers of macaroni, cheese, and sauce until the dish is filled. Bake half an hour. Add salt and pepper to the sauce just before removing it from the fire.

Baked macaroni with cheese.—Boil 6 ounces of macaroni in plenty of boiling salted water until tender. Warm a deep pudding dish and butter well; place in this a layer of the macaroni, then a layer of cheese grated or cut into small bits; sprinkle over this salt and pepper and small pieces of butter; then add another layer of macaroni and cheese, finishing off with the cheese; pour over 1 cup of rich milk or cream and bake three-quarters of an hour.

Macaroni and cheese à l'Anglaise.—Take ¼ pound of macaroni, ½ pint milk, ½ pint veal or beef gravy, yolks of 2 eggs, 4 tablespoonfuls of cream, 1 ounce butter, 3 ounces grated Parmesan or Cheshire cheese. Boil the macaroni in the gravy and milk until quite tender without being broken; drain and place in a deep dish. Beat the yolks of 2 eggs with the cream and 2 tablespoonfuls of the liquor in which the macaroni was boiled; make this sufficiently hot to thicken, but do not allow it to boil; pour it over the macaroni, over which sprinkle the grated cheese and the butter broken into small pieces. Brown with a salamander or before the fire, and serve. Do not brown in the oven, as the butter would oil and so impart a very disagreeable flavor to the dish. Time, one-half to three-fourths hour to boil macaroni, 5 minutes to thicken eggs and cream, 5 minutes to brown.

Macaroni in cheese shell.—Break macaroni into 2-inch lengths, and boil for at least 20 minutes in boiling water, well salted; then cut in pieces not over ½ inch long. Have ready a cheese shell, one which has had the cheese thoroughly scooped out. These shells are frequently thrown away, and they make very nice receptacles for the serving of macaroni. Stand the shell on a piece of waxed paper, and this in a baking pan. Put 2 tablespoonfuls of butter and 2 of flour in a saucepan; mix and add a pint of milk; stir until boiling; add the cold macaroni and stir over the fire until it is just heated through; add a teaspoonful of salt and a saltspoonful of pepper, and pour the mixture into the cheese shell; cover with a piece of greased paper and run into the oven for 15 minutes. Lift the shell carefully, putting it into a dainty round plate, and send it to the table. This imparts the most delicate cheese flavor, and also makes a sightly dish. If the shell is carefully cleaned it may be used several times. If baked too long, it will be soft and fall apart; for that reason the macaroni must be hot when poured into the shell.

Creamed macaroni.—For a baking dish holding 3 pints allow ½ pound of macaroni. Have your kettle partly filled with boiling salted water; throw in the macaroni and boil at least 20 minutes. Drain well, and turn it carefully into a baking dish. Put into a saucepan 3 tablespoonfuls of butter and 3 tablespoonfuls

of flour: mix: add 1½ pints of milk and stir until boiling; add 3 tablespoonfuls of grated Parmesan and 1 cup of chopped ordinary American cheese, a level teaspoonful of salt, and a dash of red pepper. Pour this over the macaroni, pulling it apart so that the sauce may go to the very bottom of the dish. Cover the top with a layer of cheese and then a layer of bread crumbs. Stand in a quick oven near the top, so that it may brown without being unduly cooked.

Creamed macaroni on toast.—Put 1 rounded tablespoonful of butter and 1 of flour into a small saucepan; mix over the fire until smooth; do not brown. Add ½ pint of cream; stir until it boils; take from the fire and add salt and pepper and 4 ounces of boiled macaroni, chopped fine. Place the saucepan over boiling water to reheat. Pour over slices of buttered toast, dust with grated cheese, and serve hot.

MACARONI WITH TOMATOES.

Macaroni with tomato sauce.—Boil 6 ounces of macaroni in a saucepan of boiling salted water; let boil 20 minutes; drain in a colander. Have ready the following sauce: Cook 1 quart of tomatoes for 1 hour, then strain; add to this juice 1 pint of clear soup, 1 dessertspoonful of sugar, and pepper and salt to taste. Boil all together, and while boiling cream together 2 tablespoonfuls of butter and 2 of flour; add to the sauce and stir constantly until it thickens. Serve the macaroni on small plates, very hot, and pour over it the sauce and grated Parmesan cheese.

Macaroni with tomatoes.—Boil and drain ½ pound of macaroni; add ½ cup of cream and ⅓ cup of butter; pepper and salt. Let it simmer for a short time, but do not let the macaroni get sticky. Turn into a vegetable dish, pour over it 1 pint of stewed tomatoes, season, and serve hot.

Tomatoes stuffed with macaroni.—Select large, firm tomatoes; cut off the tops and scoop out the inside pulp. Do not peel. After sprinkling the inside of the tomato shells with a very little salt, fill with cold, boiled macaroni, chopped, mixing cheese with the filling. Arrange the tomatoes in a pudding dish, replace the tops after strewing cheese on the macaroni filling, lay a cover over the tomatoes, and bake half an hour.

MACARONI WITH MEATS.

Macaroni with clams.—Chop 15 clams very fine, drain off all the liquor, scald and skim it; add 1 sliced onion, a very little salt and pepper, and simmer 10 minutes. Put in another saucepan 1 tablespoonful of butter and 1 of flour; when melted and bubbling add 1 cup of rich milk and stir until it thickens; stir into this the clam juice and cook a minute. Fill a buttered dish with alternate layers of boiled macaroni (½ pound) and clams, making the top layer macaroni. Pour over this the sauce, put a few bits of butter over the top, and brown in a quick oven. Oysters may be substituted for the clams.

Macaroni with escalloped chicken.—Take equal parts of cold chicken, boiled macaroni, and tomato sauce. Put in layers in a shallow dish and cover with buttered crumbs. Bake until brown. Any cold fowl with the stuffing and gravy may be used in the same way.

Macaroni and salmon.—Prepare the macaroni as follows: 1 cup of macaroni, broken into about 1½-inch pieces, is put into 2 quarts of rapidly boiling water in which 1 tablespoonful of salt has been dissolved, and is cooked for at least 20 minutes. It is then drained dry. Melt 2 tablespoonfuls of butter and 1 tablespoonful of oil from the salmon; add to this 3 tablespoonfuls of flour, and cook thoroughly. Then add 1 pint of milk and cook the mixture until of a creamy consistency. Arrange the macaroni and salmon, of which a 1-pound can is used,

in layers, pouring a part of the sauce each time over the salmon. Season with salt and a dash of cayenne pepper. Sprinkle buttered bread crumbs over the top and bake until browned on top.

MACARONI WITH NUTS.

Macaroni and peanuts.—1 cup of macaroni, broken into about 1½-inch pieces, ½ pound peanuts, 1 pint milk, 3 tablespoonfuls flour, 3 tablespoonfuls butter. The macaroni is put into 2 quarts of rapidly boiling water in which 1 tablespoonful of salt has been dissolved, and is cooked at least 20 minutes. It is then drained. The butter is melted in a pan, the flour added, and thoroughly cooked. Then the milk is added and the mixture cooked until of a creamy consistency. Salt, pepper, and the ground peanuts are next added to the cream sauce. Now a layer of the macaroni is put in a baking dish and a layer of the sauce and peanuts is poured on. Then another layer of macaroni and then more cream sauce and peanuts are used until the materials are consumed. Buttered crumbs are now placed on top, and the dish is placed in the oven until browned on top.

TIMBALES.

Timbales of macaroni.—Break in short lengths ½ pound of macaroni. Cook for 25 minutes in plenty of boiling salted water; dress it with butter and grated cheese; then work into this 2 eggs. Butter and bread-crumb a plain mold, and when the macaroni is nearly cold fill the mold with it, pressing it well down and leaving a hollow in the center, into which place a well-flavored mince of meat, poultry, or game; then fill the mold with more macaroni, pressed well down. Bake in a moderate oven 20 minutes; turn out and serve.

Macaroni timbale.—Boil macaroni as usual and then cut it into strips not over ¼ inch in length. Line a melon mold with these little pieces, putting the cut side next to the mold. The mold must first be buttered liberally and then dusted with bread crumbs. This will hold the pieces as they are placed. To 1 pint of meat add ½ cup of soft bread crumbs, 2 whole eggs slightly beaten, a teaspoonful of salt, a saltspoonful of pepper, and a tablespoonful of grated onion. Pack this carefully into the mold; cover and steam for 1 hour. Turn out carefully, first loosening the timbale, and pour around either a cream sauce, bechamel sauce, or tomato sauce. If this dish is carefully made, with the mold carefully lined, it is most appetizing and sightly.

Timbale of macaroni with cheese.—Mix 1 pint of finely chopped white meat of chicken with ½ cup of chopped ham; add 3 tablespoonfuls of grated cheese, a level teaspoonful of salt, and a dash of pepper. Beat the yolks of 5 eggs with the whites of 2 eggs; add ½ pint of good cream; add this to the meat, and heat carefully, stirring constantly. Then mix ½ pound of boiled macaroni that has been cut into small lengths; turn at once into a mold and steam 1 hour. This may be served with either tomato or cream sauce.

CROQUETTES.

Macaroni croquettes.—Boil ½ pound of macaroni in salted boiling water 20 minutes and drain. Butter timbale molds and line with macaroni, reserving 3 long sticks, and chop the remainder fine; mix with ½ saltspoon of salt, a dash of white pepper, a few drops of onion juice, a teaspoonful of chopped parsley, and 4 hard-boiled eggs chopped very fine. Make a cream sauce with a tablespoonful of butter and 1 of flour, creamed together with ½ pint of boiling milk. Boil 3 minutes and add the macaroni mixture; fill the molds, cut the sticks you have reserved, place

4 across the top of each mold, and bake in a pan of hot water 30 minutes in a hot oven; turn out and serve with tomato sauce.

Croquettes of macaroni.—Boil in a saucepan 4 ounces of macaroni in salted water 30 minutes; then drain on a sieve; return the macaroni to saucepan, add ½ tablespoonful butter, 4 tablespoonfuls grated cheese, and 2 ounces of finely cut ham or beef tongue; mix all together. Then spread the preparation in a shallow buttered pan, cover with buttered paper, put a light weight on top and set aside to cool; 30 minutes before serving form the mixture into cork-shaped croquettes, dip into beaten egg, and roll in freshly grated bread crumbs; fry in hot fat to a delicate brown. Lay for a few minutes on paper, then dress on a hot dish; garnish with fried parsley, and serve with tomato sauce. Croquettes of spaghetti and noodles are prepared in the same way.

GARNITURES.

Macaroni à la Milanaise.—Break 8 ounces of small macaroni into short pieces, cook them in water, and drain; put them in a saucepan with pepper and a little nutmeg, 2 cups of good gravy and 3 or 4 tablespoonfuls of tomato sauce; add 2 ounces of minced ham and some mushrooms (truffles if desired). Let simmer an instant, then mix with them at the last 2½ ounces of butter and a cupful of grated Parmesan cheese. This is used to garnish roasts.

SPAGHETTI.

Spaghetti with Swiss cheese.—Break ½ pound of spaghetti into bits not more than 1½ inches in length, and boil in slightly salted water for 20 minutes. Turn into a hot colander and set at the side of the range to drain. Grate enough Swiss cheese to make a generous half cupful and turn into a saucepan with 3 tablespoonfuls of melted butter. Stir well; add the hot spaghetti; toss and stir for a minute, or just long enough to melt the cheese; add a dash of paprika, and serve in a hot dish.

Tomato and spaghetti à l'Italienne.—Break ½ pound of spaghetti into pieces; put it with 2 quarts of boiling water over the fire; add ½ tablespoonful salt, and boil 25 to 30 minutes. Melt 1 ounce butter in a saucepan; add 1 finely chopped onion and ½ finely chopped green pepper without the seeds; cook 6 minutes; add ½ can tomatoes, ½ cupful finely chopped mushrooms, 1 teaspoonful salt, 1 teaspoonful sugar, ¼ teaspoonful pepper; cook 20 minutes. When the spaghetti is done, drain in a colander; grate 4 ounces Parmesan cheese (or 4 ounces American cheese); put the spaghetti in alternate layers in a dish with the tomatoes and grated cheese. (The cheese may be omitted if objected to.) Place the dish a few minutes in the oven, and serve. Macaroni can be prepared in the same way.

Spaghetti à l'Allemande.—Boil ½ pound of spaghetti in salted water, as in the foregoing recipe. Place at the same time a saucepan with 2 ounces butter over the fire; add ½ cupful finely chopped onions; cook 5 minutes without browning; add 1 can of tomatoes, 1 teaspoonful salt, ½ even teaspoonful pepper, 1 tablespoonful sugar; cook 15 minutes; press the tomatoes through a wire sieve; mix the yolks of 2 eggs with 1 tablespoonful cold water and add them to the tomatoes; stir a few minutes over the fire without boiling (if handy, add ½ cupful whipped cream). Drain the spaghetti in a sieve, put it in a hot dish, in alternate layers with the tomatoes; then serve. Another way is to cover the top of the dish with grated cheese and then bake a few minutes in a hot oven.

Baked spaghetti.—Boil 12 ounces of spaghetti in salted water with a little butter; drain; put in a saucepan with salt, pepper, nutmeg, a pint of bechamel sauce, 6 ounces of butter in small bits, and 6 ounces of grated Parmesan cheese; stir and toss briskly until stringy; turn into a buttered baking dish and give it a

dome form; sprinkle more cheese and bread crumbs over; add small bits of butter, and bake light brown in a brisk oven.

SALADS.

Macaroni salad.—Clean two bleached heads of endive (chicory): dress them lightly with plain French dressing and heap them in the center of an oval dish. Have ready boiling ¼ pound of mushrooms. These may either be boiled in salted water with an addition of 6 whole peppers or boiled in stock with the addition of peppers. Drain the macaroni perfectly dry and cut it into inch lengths. Mix thoroughly with a well-made mayonnaise dressing; put this around the mound of endive, garnish with hard-boiled eggs cut into slices, alternated with slices of raw tomato, and dotted here and there with little bits of cold boiled ham.

DESSERTS.

Indian macaroni.—Place ½ pound of boiled macaroni in a pint of milk and let it come to a boil: add sugar to taste and a teaspoonful of prepared cocoanut. When this is slightly cool, pour into a glass dish and garnish with fried pistachio nuts and blanched and fried sultana raisins, seeded. Over the top sprinkle a few pistachio nuts chopped fine.

Macaroni and pineapple.—One pint clear lemon jelly, ½ tin preserved pineapple, ½ pound loaf sugar, 6 ounces macaroni, ½ pint custard, milk, and cochineal. Wet a border mold and pour in sufficient jelly to coat it. In this lay the "pine" cut into dice, after draining it from the sirup, color the remainder of the jelly with a few drops of cochineal, and fill up the mold. Boil the macaroni in milk until tender, and sweeten it with the sugar. When the jelly is set and the macaroni cold, turn out the former and fill with the latter, pour over a boiled custard flavored with bay laurel leaves, lemon rind, or vanilla, and serve.

Macaroni pudding.—Four ounces of macaroni, 1½ pints of milk, 3 eggs, 2 tablespoonfuls of brown sugar. Boil the macaroni until tender in a pint of milk, then put it in a buttered pie dish, add the sugar, the remainder of the milk, and the eggs, well beaten. Bake one-half hour.

Macaroni pudding, sweet.—Take 2½ ounces of macaroni, 2 pints of milk, rind of half a lemon, 3 eggs, sugar and nutmeg to taste. Put the macaroni with a pint of the milk into a saucepan with the lemon peel and let it simmer gently until tender; then put it into a pie dish without the peel, mix the other pint of milk with the eggs, stir these well together, adding the sugar, and pour the mixture over the macaroni which has been drained. Grate a little nutmeg over the top and bake in a moderate oven for half an hour. To make this pudding look nice a paste should be laid around the edge of the dish, and for variety a layer of preserve or marmalade may be placed on the macaroni. It will be found desirable to boil the macaroni in salted water about 15 minutes before boiling it in the milk.

Semoule cake.—Put in a saucepan a pound and a half of semolina, with 3 pints of boiled milk, 6 ounces of sugar, 3 ounces of butter, and the rind of a lemon tied up; set to boil, stir, then cover, and let simmer 40 minutes; take off the fire, remove the lemon, add 3 well-beaten eggs, 4 egg yolks, and 2 more ounces of butter, and mix well; butter a plain charlotte mold; besprinkle with fresh bread crumbs and small bits of butter on top; place on a baking sheet and cook in a fairly hot oven for about 30 minutes; pass a knife between the cake and the sides, invert on a dish, take off the mold, and serve with a sauce bowl of lemon sauce. For the lemon sauce, put in a saucepan 4 egg yolks, 4 ounces of sugar, an ounce of cornstarch, and the rind of a lemon chopped fine; mix well, dilute with a pint of boiling milk, put on the fire, stir briskly with an egg beater until the sauce thickens, and serve.

Vermicelli cake à la vanille.—Boil 3 pints of cream with 4 ounces of sugar; put in 12 ounces of large vermicelli, stir to a boil, add a vanilla bean, cover, and cook very slowly for half an hour; take off the fire, remove the vanilla, and mix with 4 beaten eggs and 4 ounces of butter; butter and bread-crumb a plain charlotte mold in this way: Roll beaten eggs all over the inside, drain the eggs, and bread-crumb; fill the mold, sprinkle more crumbs over, add small bits of butter, and bake in a moderate oven for 40 minutes; turn on a dish, and let stand a while with the mold on; then remove it; sprinkle with powdered sugar, pour a vanilla sauce around, and serve with more sauce in a sauce bowl.

SPECIAL ITALIAN RECIPES.

Raveola.—Take 3 pounds of beef, cover with cold water; add to this 1 bay leaf, 6 whole cloves, 1 minced onion, and 1 pint of tomatoes; simmer till the meat is very tender; remove the meat, and strain the sauce. Have ready half a can of button mushrooms, sliced; place these in a bowl with 2 sliced garlic corns, mix well together, cover, and allow to remain for an hour. Boil ½ pound of macaroni in plenty of boiling salted water 20 minutes and drain. Carefully pour over the bottom of a platter 1 tablespoonful of olive oil and place on this the macaroni; pour over this 2 tablespoonfuls of olive oil; heat the sauce to boiling point and add the mushrooms and garlic; pour over the macaroni and mix thoroughly; sprinkle with grated Parmesan cheese. Garnish the dish with fried spring chicken, string beans, or green corn cut from the cob. This is said to be the national dish of Italy.

Italian macaroni, baked.—Place 2 pounds of beef, well larded with strips of salt pork, and 1 or 2 chopped onions in a covered kettle on the back of the stove until it throws out its juice and is a rich brown; then add 1 quart of tomatoes seasoned with pepper and salt, and allow the mixture to simmer for 2 or 3 hours. Take the quantity of macaroni desired and boil in plenty of boiling salted water for 20 minutes and drain. Place a layer of the macaroni in the bottom of a buttered pudding dish, cover with some of the above sauce, sprinkle well with grated cheese, and continue to fill up the dish with alternate layers of macaroni, sauce, and cheese, having a layer of cheese on the top. Place in the oven and bake a rich brown. Commence early in the morning to prepare this dish, as the meat must cook slowly in order to have a rich sauce.

Macaroni à l'Italienne.—Peel and cut into small pieces 12 large tomatoes, put into a soup kettle with 3 pounds of soup meat, and allow to simmer gently for 1 hour (care must be taken to prevent scorching). Throw ½ pound of macaroni into boiling salted water and boil 20 minutes; drain; add the macaroni to the stock in which the meat was boiled, and cook 10 minutes; take out the macaroni and drain; add to the strained stock 2 cloves of garlic mashed, 2 bay leaves; simmer 5 minutes, add the macaroni, and stir until thoroughly seasoned and perfectly tender; then add ½ cup of cream and serve with grated Parmesan cheese in a separate dish.

Macaroni à la Napolitaine.—Break ½ pound of macaroni and throw into rapidly boiling salted water; boil rapidly for 10 minutes, strain, and put into a saucepan; cover with good beef or chicken stock, and boil for 30 minutes. By this time the stock will be nearly absorbed. Strain the macaroni and place it where it will keep warm. Add to the stock 2 tablespoonfuls of thick tomato sauce; mix until smooth; add a chopped sweet red pepper, half a cup of toasted pinolas, a teaspoonful of salt, and a pinch of white pepper; boil for 3 minutes; then add the macaroni, cover in a double boiler, and stand over the fire for 15 minutes, until the macaroni is nicely seasoned. Just at serving time add a cup of very thick cream or 2 tablespoonfuls of sweet butter. Turn out on a platter and serve with it, in a separate dish, grated Parmesan cheese.

MISCELLANEOUS.

Macaroni soufflé.—Into 1 cup of cream sauce seasoned with minced parsley and onion juice stir 1 cup of chopped, boiled macaroni; when hot add the beaten yolk of 2 eggs, cook 1 minute, and set away to cool. When cold stir in the beaten whites of the 2 eggs, beaten very stiff; cover with grated cheese or crumbs, and bake in a buttered dish 20 minutes. Serve with mushroom sauce.

Macaroni with celery.—Break ½ pound of macaroni into small pieces, put it into 2 quarts of rapidly boiling salted water, and boil for 20 minutes. Drain in colander. Cut up enough celery to make a large cupful; stew until tender in just enough water to cover. Butter a baking dish, pour in half of the prepared macaroni, then half of the celery, and sprinkle with a saltspoon of salt; put in the balance of the macaroni and celery and repeat the salt; cover with buttered bread crumbs; sprinkle a teaspoonful of grated cheese over this, and pour over all the water in which the celery was boiled. Bake in a moderate oven 20 minutes.

Macaroni à la national.—Break ½ pound of macaroni into 3-inch pieces and boil until tender in well-salted water and drain in a colander. Pour into a shallow baking dish and cover with the following sauce: Put 2 tablespoonfuls of butter in a granite saucepan and stir until it melts, being careful not to brown it; add to this 1 tablespoonful of flour and stir until thoroughly mixed; bring 1½ cups of milk to the boiling point and add to the flour and butter; stir all thoroughly until it thickens and becomes smooth; pepper and salt to taste. Mix ⅔ of a cup of fine cracker crumbs with ½ cup of grated cheese, ½ cup of melted butter, and sprinkle over the top. Bake until brown and serve hot.

Deviled macaroni.—Boil 6 ounces of macaroni, and chop rather fine. Put 2 tablespoonfuls of butter and 2 of flour in a saucepan, mix well, and add a pint of milk; stir until boiling. Then add, pressed through a sieve, the hard-boiled yolks of 3 eggs and the whites of the eggs pressed through a vegetable press; add a tablespoonful of chopped parsley, a level saltspoon of red pepper, one chopped sweet Spanish pepper, a grating of nutmeg, a teaspoonful of grated onion, and the macaroni. Put this into individual shells or cases, cover the top with bread crumbs that have been moistened with melted butter, and brown in a quick oven. In serving put a teaspoonful of tomato catsup or chili sauce in the center of each dish.

Macaroni with eggs.—Take ¼ pound of macaroni that has been boiled in a buttered dish; season with salt, pepper, and butter; grate over it an ounce of cheese; stir 2 eggs in a cup of milk and pour over it. Cover with bread crumbs and bake 20 minutes, or until brown.

Fried macaroni.—Take 6 ounces of macaroni; boil until tender. Take an onion and 3 tablespoons of chopped ham; fry brown; then add the macaroni, 1 teacup of tomato juice, and salt to taste; cover top with grated cheese and bake until brown.

Macaroni au gratin.—Melt 1 tablespoonful of butter without browning; add 1 tablespoonful of flour; mix until smooth; add 1 cup of cream and stir until it thickens; season with salt and pepper. Just as you take it from the fire stir in quickly the yolk of 1 egg. Do not let the sauce stand on the fire after the egg has been added or it will curdle. Boil 8 ounces of macaroni in plenty of salted boiling water; drain; melt 4 ounces of cheese with 2 tablespoonfuls of butter. Grease a baking dish and fill with alternate layers of macaroni and sauce. Pour the melted butter and cheese over the top that it may penetrate the whole dish. Cover with bread crumbs and brown in a quick oven.

Macaroni with brown sauce.—Melt 2 tablespoonfuls of butter; add 2 tablespoonfuls of flour and mix until smooth and brown. Then add 1 pint from the stock

of water in which ¼ pound of macaroni was boiled; stir until it thickens; add the macaroni and 1 tablespoonful of tomato catsup; stir until heated through; season and serve.

Macaroni and mushrooms.—Cover the bottom of a baking dish with about a tablespoonful of melted butter; then put over a layer of macaroni that has been boiled 15 minutes, and sprinkle lightly with salt and pepper, and dot here and there with bits of butter. Now put over a thick layer of washed mushrooms cut into slices, then a layer of macaroni, and so continue until the dish is full, having the last layer macaroni. Pour over 1 pint of cream. Cover with a lid or another pan, and bake in a moderate oven 1 hour; then remove the cover and brown quickly.

Macaroni and onion fritters.—Cut 2 ounces of boiled macaroni into small pieces; add 4 onions boiled and chopped, 6 ounces bread crumbs moistened with a little water, and 3 eggs well beaten; season with pepper and salt; fry and serve with brown sauce.

Macaroni rarebit.—Put into a chafing dish 2 cups of boiled macaroni cut into 2-inch pieces. 1 cup of grated cheese, 2 tablespoonfuls of butter, ½ teaspoonful each of salt, mustard, and red pepper; when boiling add 3 eggs well beaten with ½ cupful of cream or milk. Serve hot on toast.

Spanish macaroni.—Boil separately in salted water or milk 4 turnips and ½ pound of macaroni until tender. Put the macaroni in a baking dish, baste over with butter, and pour over it the following (mixed) ingredients: Mashed turnip, minced red pepper, minced 2 onions, minced ½ pound of ham, using milk to thin it to the consistency of a heavy batter; over the top grate cheese plentifully, and bake.

Stewed macaroni.—Put 4 ounces of good macaroni as little broken as possible into a large saucepan of boiling water; boil 5 minutes and drain; then cover with 1 pint of beef stock; add ½ teaspoonful of salt and a saltspoonful of pepper. Push the saucepan away on the corner of the fire where the macaroni will simmer until tender—it must not be soft or flabby; toss it now and then with a fork to prevent sticking. When the stock has been entirely absorbed add ½ teaspoonful of beef extract that has been moistened in a little water and to which has been added a tablespoonful of browned flour. Toss this for a few moments over the fire, add ½ cup of good cream, and turn on to a heated shallow dish. Pour over a tomato sauce made by rubbing together 1 tablespoonful of butter and 1 of flour, to which has been added ½ pint of strained tomato; stir until boiling; add ½ teaspoonful of salt and a dash of pepper. Pass with this grated Parmesan cheese or sap sago.

Macaroni with corn.—Boil 1 cup of macaroni which has been broken into inch lengths in boiling salted water until tender. Drain and add to it 1 cup of corn cut from the cob (or 1 cup of canned corn), a little salt, two tablespoonfuls of zwieola,[a] 1 egg well beaten, and 1½ cups of nut milk. Mix thoroughly and bake in a granite pudding dish.

Macaroni piquante.—Break spaghetti into very small bits less than an inch in length; boil these for 20 minutes, or until tender, in salted water. Drain and keep hot while the following sauce is made: Cook together in a saucepan a heaping teaspoonful each of butter and browned flour, and when these are blended to a reddish brown pour upon them a pint of beef stock and stir until smooth; now add 4 tablespoonfuls of tomato catsup, 6 drops of Tabasco sauce, a teaspoonful of kitchen bouquet, a pinch of salt, and a dash of paprika. Turn the boiled spaghetti into this sauce, stir all together, and pour the mixture into a greased pudding dish. Sprinkle buttered crumbs and grated cheese over the top and bake until brown.

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[a] A kind of cracker crumbed. Bread crumbs may be substituted.

Macaroni rissoles.—Have ready a cupful of cold, boiled macaroni cut up small. Make a white sauce by cooking together a tablespoonful of butter and two of flour and stirring into them a cupful of hot milk. Stir until thick, add a large tablespoonful of grated cheese, and, gradually, the whipped yolks of 4 eggs, beating all the time. Work the macaroni into the sauce and set aside until the mixture is very cold. With floured hands form into small balls—not quite as large in circumference as a silver dollar—roll in beaten egg, then in fine cracker crumbs, and set in the ice box for 2 hours. Fry in deep-boiling cottolene or other fat. Serve with tomato sauce.

DURUM WHEAT FOR BREAD.

For some time the writers have been convinced that a good bread can be made from durum wheat, and it has been known to one of them since 1898 that the best and most popular bread in France and Russia is made from this wheat. It was thought best, however, not to urge the use of the wheat for such a purpose in this country until people had become more familiar with it and until a fair market had already been established for its use in the production of macaroni and other products. In the season of 1902 for the first time a comparatively large amount of durum wheat was harvested, somewhere near 2,000,000 bushels, which naturally resulted in trials of the wheat for other purposes than making macaroni. Through the efforts of a number of flour mills many families were induced to use the wheat for bread over considerable areas in North and South Dakota, and finally during the winter of 1902 in a number of localities in those States private bakings were made almost solely from the durum wheat, and that, too, in face of the fact that in these very localities the best quality of ordinary hard spring wheat is grown and the people had abundant opportunity to obtain bread of the same class as that produced from Minneapolis flour. In at least one town of North Dakota practically the entire population used the durum-wheat flour for bread and continued afterwards to do so, even though such flour occasionally sold at a higher price than that made from the hard spring wheat.

PRIVATE EXPERIMENTS.

In addition to these family bakings, experiments with this wheat for bread were made by a number of private institutions. Among these experiments were those made by a baking company in Cleveland, Ohio, in which case the flour was obtained from a North Dakota mill. From a letter from this mill, dated March 16, 1903, the following words are quoted:

> We presume you are collecting more or less information from various sources in regard to the bread-making qualities of macaroni flour. To that end we will contribute the contents of a letter which we received from our flour commission merchant of Cleveland, Ohio. The letter reads as follows: "The —— Company condemned the macaroni flour for bread purposes on first trial. Upon our recom-

mendation they began to experiment, and with great success, and they are more than pleased with the results. Will have meeting with head baker and report."

Our commission merchant had sold a carload of flour to this Cleveland company. Twenty-five barrels of the shipment were macaroni straight flour. If you would take the matter up direct with the company, I have no doubt they will give you a full and complete report on their experiments.

Later on, the following testimonial came from the commission merchant referred to above:

Through your courtesy nearly a year ago we secured the agency for macaroni flour from one of the mills that you were kind enough to hand me the address of. We thank you for the same. This flour we sold to macaroni manufacturers with one exception; this was sold to a large bakery. We desire to say that it was very satisfactory in every instance; the bread was very rich and of a fine flavor, and for family use we have never found any flour to equal it as far as flavor and richness are concerned. We have sold to some of the large bakeries here this season for further experiments. If you so desire, we will hand you further results when they are completed.

Afterwards more definite information was obtained concerning the actual baking trials of the Cleveland bakery in the following words, which are quoted from another letter of later date:

We have your favor of October 5, same being carefully noted, and thank you for the information. Will further state that we sold the —— Company the macaroni flour. Their head baker learned his trade in Egypt; afterwards he became a soldier, following up the baking, and when near the Black Sea he had experience with a flour very similar, so it was not new to him. He first baked it separate, then blended it with No. 1 Northern. The first test did not give expansion enough; the second was fine. His words, in short, are: "A very rich and fine-flavored loaf."

Now, they did not make a scientific test, as they were building and generally mixed up, which was no doubt the reason you have not heard from your last communication. The management has changed hands, and the present company does not know much about it. When they receive their macaroni patent they expect to give it a thorough test. Will then advise you further.

Our last season's sales of macaroni flour and semolina amounted to about 3,400 barrels, all local trade. We have to-day submitted an offer to our mill for 4,000 barrels from one concern, and more to follow.

It is a significant fact mentioned in this last letter that the head baker had learned his trade in Egypt and afterwards practiced his trade in the region of the Black Sea, since a large amount of durum wheat is grown in those districts, and he had therefore become familiar with the use of that wheat for bread and knew just how to handle it.

During the winter of 1902–3 a number of thorough tests of durum wheat for flour in comparison with ordinary wheat were made by several commercial wheat and flour testing laboratories in some of the large cities. Tabulated results of one of these tests made by a well-known laboratory are here reproduced. In these tests both chemical analyses of the wheat and baking tests of the flour of three varieties of durum wheat were made in comparison with an average

northwestern spring wheat. The samples were ground in a small experimental mill, and straight flour was used in the baking tests in all cases. These results are given in the first table. For further comparison another table is added in which tests of a number of other flours, including the standard patents, Ceresota, Gold Medal, and Pillsbury's Best, are shown by the side of those obtained with the three durum wheats.

TABLE 2.—*Test of durum wheat and flour, made in a commercial laboratory.*

CHEMICAL ANALYSES OF THE WHEAT SAMPLES.

Composition.	No. 1. Pelissier (durum).	No. 2. Gharnovka (durum).	No. 3. Arnautka (durum).	An average northwestern spring wheat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	11.100	11.100	12.400	11.9
Ash	1.570	1.640	1.330	1.9
Total nitrogenous compounds	14.600	14.000	12.800	12.3
Gliadin	6.200	6.000	4.900	4.8
Glutenin	6.300	5.700	5.600	5.0
Other nitrogenous compounds	2.100	2.300	2.300	2.5
Acidity	.218	.165	.172	.2
Soluble carbohydrates	2.600	2.400	2.400	1.8
Starch	54.200	56.000	56.200	55.0
Yield	77.500	80.000	80.300	78.6

CHARACTER OF FLOUR MADE FROM THE WHEAT SAMPLES.

Composition.	No. 1. Pelissier (durum).	No. 2. Gharnovka (durum).	No. 3. Arnautka (durum).	An average northwestern spring wheat.
Quality of dough	Grayish, white, fairly elastic.	Creamy, white, fairly elastic.	Grayish, white, creamy, fairly elastic.	Grayish, white, elastic.
Color of loaf [a]	3	2.5	Good, 3	2
Volume of loaf, cubic inches	117	143	120	186
Weight of loaf, ounces	18.13	17.81	17.31	17.25
Water used, ounces	7.31	7.19	6.94	7.00

[a] Maximum of whiteness, 2.5; medium, 3; minimum, 3.5.

Remarks.—Moisture of all three wheats is normal in comparison with bread wheats. Ash is somewhat lower than in bread wheats. Total nitrogenous compounds include the two compounds which make up gluten—gliadin and glutenin—and other soluble nitrogenous compounds which are present in smaller amounts. Nos. 1 and 2 are very high in nitrogenous compounds, and No. 3 contains about the same amount as a good spring wheat. The gliadin and glutenin are present in large amount and the other nitrogenous compounds in average amount. The acidity is a measure of soundness, and, being normal in all, shows them to be sound. The percentage of soluble carbohydrates (sugars, gums, and soluble starch) is slightly higher than in bread wheats. These components are the easily fermentable materials, and consequently the keeping qualities of the flours will not be quite as good as those of bread wheat flours. The starch analysis is made to get an idea of the yield, since, generally speaking, the yield is proportional to the starch, and under the assumption that 70 per cent of average flour is starch the yields would be as shown. The yield is intended to mean the absolute amount of flour or endosperm in the wheat berry, but of course in the mill an absolute separation is impossible. In reality the yields are higher than the above, since macaroni flours are not as starchy as ordinary flours, probably 65 per cent would be a better assumption, in which case the yields would be, respectively, 83.4, 86.2, and 86.5 per cent; but the yields are at least comparative with each other.

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TABLE 3.—*General comparative baking results with bread from different flours.*

Mill name or marks.	Patents and straights.				First and second clears.			
	Color.	Volume.	Weight.	Water used, more or less than standard formula.	Color.	Volume.	Weight.	Water used, more or less than standard formula.
		Cubic in.	*Ounces.*	*Ounces.*		*Cubic in.*	*Ounces.*	*Ounces.*
"Ceresota"	1	195	17.44	0.19 more.	.....	.....	.....	
"Gold Medal"	1	195	17.63	.44 more.	.....	.....	.....	
"Pillsbury's Best"	1.5	195	17.75	.63 more.	.....	.....	.....	
Standard patent	1	195	17.63	.31 more.	4	180	17.50	0.13 more.
Do	1.5	188	17.63	.25 more.	.....	.....	.....	
Do	1	193	17.19	Regular.	5	162	17.50	.13 more.
Do	1	190	17.25	0.06 more.	.....	.....	.....	
Do	1	192	17.25	Regular.	4	175	17.31	.06 more.
Do	1.5	200	17.38	0.19 more.	5	160	17.75	.31 more.
Do	1	190	17.25	Regular.	5	158	17.56	.13 more.
Do	1.5	190	17.31	0.06 more.	4	180	17.50	.13 more.
Do	2	180	18.00	.56 more.	4	172	17.75	.31 more.
Do	1	186	18.00	.63 more.	.....	.....	.....	
Do	1	190	17.63	.25 more.	.....	.....	.....	
Do	1	194	17.50	.13 more.	.....	.....	.....	
Do	1.5	196	17.44	.19 more.	.....	.....	.....	
Do	1.5	192	17.25	Regular.	.....	.....	.....	
Do	1.5	195	17.19	....do.....	.....	.....	.....	
Pelissier, Algiers	3	117	18.13	0.31 more.	.....	.....	.....	
Gharnovka, Russia	2.5	143	17.81	.19 more.	.....	.....	.....	
Arnautka, North Dakota.	3	120	17.31	.06 less.	.....	.....	.....	

Explanation of headings.—Color: Patents—Maximum 1, medium 1.5, minimum 2; straights—maximum 2.5, medium 3, minimum 3.5; first clears—maximum 4, medium 5, minimum 6; second clears—good 7 to poor 8. Volume (expressed in cubic inches) indicates elasticity or rising power, showing whether the sample is in proper baking condition or has the right combination of properties (starch and gluten) in itself to produce a good-sized loaf. Twelve ounces flour in each loaf. Weight of loaf expressed in ounces decimally. Amount of water used indicated decimally by more or less than standard formula, 7 ounces.

Remarks.—The baking test on the flours as milled is appended for comparison, and the results are self-explanatory. In general these wheats are sound, of fair color, fair absorbers of moisture, and not able to produce large loaves in the baking test. Milling these wheats with bread wheats is impracticable, but mixtures of the two kinds of flours should be experimented with. Macaroni bread has a fine flavor and pound for pound contains more nourishment than any other wheat flour.

COOPERATIVE BAKING EXPERIMENTS OF THE DEPARTMENT OF AGRICULTURE.

So much interest in the subject having been developed through such experiments as these described, it was thought desirable for the Department of Agriculture to conduct a more complete series of experiments on a comparatively large scale in the use of durum wheat flour for bread. During April, 1903, satisfactory arrangements were made with one of the large bakeries of the country to cooperate in carrying out these experiments, the bakery to complete all tests in the actual bread making and the Department to make the analyses of the flour and the later physical and chemical tests of the bread after the baking. In these experiments the durum wheat bread was made from a "macaroni patent" flour produced by a North Dakota mill which had up to that time given the most attention to the production of this kind of flour. (Pl. I, Frontispiece.) The bread for comparison was a well-known product of this bakery made at that time from one of the best hard spring wheat flours obtainable, a blend of two northwestern patents. The results of observation on the flour and

dough and operations in the mixing department in the case of this test are given in the following tabular statements. Similar observations are made with the greatest accuracy, and similar care is taken in the mixing operations in this bakery preceding all its regular bakings.

TABLES OF MIXING OPERATIONS.

TABLE 4.—*Constituents of dough.*

Hard spring wheat bread marked "P."	Weight.	Durum wheat bread marked "X."	Weight.
	Pounds.		*Pounds.*
Flour, hard spring wheat patent	196	Flour, macaroni patent	167
Water	101	Water	86
Milk	50	Milk	42
Sugar	6½	Sugar	5½
Salt	4⅜	Salt	4
Lard	6	Lard	4⅜
Yeast	1½	Yeast	1¼
Total number of loaves produced	321	Total number of loaves produced	261

TABLE 5.—*Conditions of mixing.*[a]

Kind of dough.	Temperature.	Time.
	° *F.*	
"P"—hard spring wheat:		
Outside	52	9.07
Air	59	9.10
Shop	64	9.07
Mixture tank	94	9.05
Liquid in machine	92	9.03
Dough when made	79	9.30
Time dough started	92	9.07
"X"—durum wheat:		
Outside	56	8.54
Air	56	9.00
Shop	63	8.54
Mixture tank	96	8.50
Liquid in machine	92	8.52
Dough when made	79	9.30
Time dough started	92	8.54

[a] Number of revolutions of mixing machine: "P," 1,700; "X," 2,160. The increased number of revolutions for "X" is accounted for by the smaller dough, necessitating greater motion in taking hold of it.

TABLE 6.—*Making up the loaves.*

Kind of dough.	Time when taken.	Total number of loaves.	Men on dough.	Flour for dusting.
				Pounds.
"P"—hard spring wheat	3.30	321	2	5
"X"—durum wheat	3.30	261	2	5

The durum wheat bread proved in one hour and thirty minutes; hard spring wheat bread proved in one hour and twenty minutes. The temperature of ovens was 500° F. The hard spring wheat bread baked in thirty minutes. The durum wheat bread baked in thirty-five minutes.

A complete report on the chemical analyses of the flour used, in comparison with a number of other flours and the later Department tests of the bread, is here produced, prepared entirely by one of the writers, Dr. J. S. Chamberlain.

CHEMICAL STUDY OF DURUM WHEAT FLOUR AND BREAD.

Examination of standard flours.—In order to show a comparison not only of the two flours used in the baking test, but also of several typical flours, the following list of twenty-nine samples was selected and analyses were made of them. The list embraces flours from four different classes of wheat, viz, durum wheat, northwestern hard spring wheat, Kansas hard winter wheat, and soft winter wheat. The flours were of two grades—straight and patent—the latter including both first and second patents, the former being what is sometimes termed standard patent or straight patent.

The flours are as follows:

103. Durum wheat flour, patent grade, North Dakota, 1902.
107. Durum wheat flour, patent grade, North Dakota, 1902.
109. Durum wheat flour, patent grade, North Dakota, 1902.
115. Durum wheat flour, patent grade, used in bread test, North Dakota, 1902.
234. Durum wheat flour, patent grade, North Dakota, 1903.
202. Durum wheat flour, patent grade, Minnesota, 1903.
241. Durum wheat flour, patent grade, Minnesota, 1903.
248. Durum wheat flour, patent grade, Minnesota, 1903.
240. Durum wheat flour, patent grade, Nebraska, 1903.
245. Durum wheat flour, patent grade, Pennsylvania milled, 1903.
101. Durum wheat flour, straight grade, North Dakota, 1902.
160. Durum wheat flour, straight grade, laboratory mill, Velvet Don variety, grown in Russia in 1901.
166. Durum wheat flour, straight grade, laboratory mill, Velvet Don variety, grown in South Dakota in 1901.
135. Hard spring wheat flour, patent grade, Minneapolis mill, 1902.
200. Hard spring wheat flour, patent grade, Minneapolis mill, 1902.
116. Hard spring wheat flour, patent grade, North Dakota mill, 1902; used in bread test.
125. Hard spring wheat flour, patent grade, North Dakota, 1902.
246. A blend of hard spring and hard winter wheat flours, patent grade, Nebraska, 1903.
247. Hard spring wheat flour, patent grade, Minnesota, 1903.
124. Hard spring wheat flour, straight grade, North Dakota, 1901.
123. Hard spring wheat flour, straight grade, North Dakota, 1902.
242. Hard spring wheat flour, straight grade, North Dakota, 1903.
129. Hard winter wheat flour, Turkey variety, straight grade, Kansas, 1902.
130. Hard winter wheat flour, Turkey variety, patent grade, Kansas, 1902.
168. Hard winter wheat flour, Turkey variety, straight grade, laboratory mill, 1902.
169. Hard winter wheat flour, Turkey variety, straight grade, laboratory mill, 1902.
176. Soft winter wheat flour, Fultz variety, patent grade, St. Louis, 1902.
194. Soft winter wheat flour, straight grade, Pennsylvania, 1902.
195. Soft winter wheat flour, straight grade, Pennsylvania, 1903.

In the analyses special attention was given only to the determination of the proteid constituents and to the separation of these into three parts, viz, into proteids soluble in dilute salt solutions, proteid soluble in 70 per cent alcohol (gliadin), and proteid insoluble in alcohol or salt solutions (glutenin). The determinations of nitrogen in these and the other analyses were made by the Gunning method by Mr. T. C. Trescot, of the Bureau of Chemistry.

In the following table (Table 7) will be seen the results of the analyses. The results are all figured on dry material, with the exception of the determinations of absorption and expansion and of the gluten, which were figured in both ways, the percentage amounts of water in the air-dry flour being given in the first column. In addition to the gliadin, glutenin, proteids soluble in salt solution, total proteids, and the various ratios and relations derived from these, there are also given the gluten by washing, and the absorption, ash, and expansion when it was possible to determine them. It will be seen almost at a glance that the amounts of gliadin and glutenin given in this table do not agree with those given by some writers, which vary from 50 to 75 per cent gliadin. Without going into the question of the reason for different results by different investigators, thus necessitating a long technical discussion of methods, the results are given for their comparative value in this particular case, and the description of methods used and a discussion of the whole question of the proteid constituents of flour will be given in another and later publication.

In Table 8 a few of the results obtained from the patent flours have been brought together for a better comparison of the durum and hard spring wheat flours, and also to show the difference between the flour from the wheat crop of 1902 and that of 1903.

TABLE 7.—*Analyses of flour from durum wheat and flour from other kinds of wheat.*

Number.	Wheat.	Locality of mill.	Grade of flour.	Wheat crop.	Date of milling (approximate).	Water, per cent at 105° C.	Proteids, total per cent by determination.	Gliadin, per cent.	Glutenin, per cent.	Other proteids, per cent.	Sum, per cent.	Gliadin+glutenin, per cent of total proteids (sum).	Gliadin, per cent of gliadin + glutenin.	Glutenin, per cent of gliadin+glutenin.	Gliadin+glutenin, per cent of flour.	Gluten, per cent, dry basis.	Gluten, per cent, air-dry basis.	Absorption, cubic centimeters water per 100 grams flour, air-dry basis.	Expansion, in cubic centimeters, per 100 grams flour, air-dry basis.	Ash, dry basis.
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
103	Durum	North Dakota	Patent	1902	Feb., 1903	9.41	12.64	5.96	4.80	1.99	12.75	84.39	55.39	44.61	10.76	16.42	14.87	68	640	0.64
107	do	do	do	1902	Jan., 1903	8.64	15.27	7.32	5.40	2.16	14.88	85.48	57.55	42.55	12.72	17.99	16.43			.90
109	do	do	do	1902	Feb., 1903	11.49	12.52	6.23	4.66	1.95	12.61	86.36	57.20	42.80	10.89	13.16	11.65	69	600	.91
115	do	do	do	1902	Mar., 1903	11.76	12.38	5.70	4.83	1.90	12.44	85.18	54.13	45.87	10.53	14.18	12.52	68	600	.80
234	do	do	do	1903	Jan., 1904	9.31	12.32	4.64	5.42	2.27	12.33	81.59	46.12	53.88	10.06	13.45	12.20	66	580	.94
202	do	Minnesota	do	1903	Oct., 1903	12.16	11.36	5.51	4.25	1.73	11.49	84.94	56.45	43.55	9.76	13.03	11.45	64	660	.60
241	do	do	do	1903	Dec., 1903	9.07	12.10	4.86	5.45	2.02	12.33	83.61	47.13	52.87	10.31	12.38	11.26	66	610	.74
248	do	do	do	1903	Feb., 1904	12.23	11.64	5.15	4.90	1.70	11.75	85.53	51.24	48.76	10.05	13.04	11.43	62	580	.50
240	do	Nebraska	do	1903	do	12.39	13.40	5.85	5.17	2.10	13.12	84.00	53.08	46.92	11.02	14.36	12.58	65	645	.93
245	do	Pennsylvania	do	1903	Mar., 1904	10.04	12.50	5.29	5.08	2.21	12.58	82.43	51.01	48.99	10.37	13.32	11.98	63	610	.76
101	do	North Dakota	Straight	1902	Feb., 1903	10.37	13.12	5.91	5.05	1.99	12.95	84.63	53.92	46.08	10.96	15.66	14.03	73	610	.74
160	do	Laboratory mill.	do	[a] 1901	June, 1903	11.95	17.77	7.38	7.10	3.29	17.77	81.48	50.96	49.04	14.48	20.65	18.19			1.09
166	do	do	do	[b] 1901	do	12.14	16.06	6.82	6.77	2.78	16.27	82.75	51.31	48.69	13.29	18.56	16.31			.93
135	Northwestern spring.	Minneapolis	Patent	1902	Mar., 1903	10.00	13.36	6.07	5.28	1.82	13.17	86.17	53.47	46.53	11.35	13.50	12.15	65	610	.55
209	do	do	do	1902	do	13.04	13.12	6.29	5.11	1.70	13.10	87.02	55.18	44.82	11.40	13.48	11.72	62	625	.51
116	do	North Dakota	do	1902	do	12.42	14.40	7.04	5.31	1.82	14.18	87.16	57.02	42.98	12.35	13.98	12.25	66	620	.57
125	do	do	do	1902	do	11.30	12.47	5.99	4.54	2.08	12.61	83.50	56.88	43.06	10.53	12.84	11.39	62	570	.56
246	Northwestern spring (blend).	Nebraska	do	1903	Feb., 1904	11.65	11.98	5.31	5.31	1.87	12.49	85.02	50.00	50.00	10.62	13.03	11.51	58	600	.51
247	Northwestern spring.	Minnesota	do	1903	do	13.09	12.72	5.62	5.96	1.99	13.57	85.33	48.53	51.47	11.58	14.35	12.47	60	600	.58
124	do	North Dakota	Straight	1901	(?)	10.95	14.14	6.62	5.57	2.13	14.32	85.12	54.30	45.70	12.19	16.73	14.90	64		.49
123	do	do	do	1902	Mar., 1903	10.88	12.25	5.59	4.71	2.19	12.49	82.46	54.27	45.73	10.30	14.50	12.92	60		.61
242	do	do	do	1903	Feb., 1904	9.65	13.80	6.45	5.57	2.18	14.20	84.64	53.66	46.34	12.02	14.23	12.86	68	555	.59

130	Kansas hard winter.	Kansas	Patent	1902	Feb., 1903	11.35	12.85	6.51	4.49	1.78	12.78	86.03	59.19	40.81	11.00	12.64	11.21	62	540	.57
129	do	do	Straight	1902	do	11.71	14.88	6.78	6.13	2.26	15.17	85.10	52.51	47.49	12.91	16.33	14.42			.77
168	do	Laboratory mill.	do	1902	June, 1903	12.69	14.40	6.42	6.02	2.16	14.60	85.20	51.60	48.40	12.44	15.22	13.29			.68
169	do	do	do	1902	do	11.31	14.79	5.91	6.08	3.24	15.23	78.72	49.25	50.75	11.99	16.21	14.38			.77
176	Soft winter	St. Louis	Patent	1902	(?)	11.39	9.05	3.63	3.41	1.99	9.03	77.96	51.56	48.44	7.04			56	650	
194	do	Pennsylvania	do	1902	June, 1903	12.43	10.57	4.42	4.32	1.88	10.62	82.29	50.57	49.43	8.74	11.25	9.85	54	660	.58
195	do	do	do	1903	Aug., 1903	12.40	9.09	4.31	3.58	1.42	9.31	84.75	54.62	45.38	7.89	9.67	8.47	53	640	.63

[a] Russian.

[b] South Dakota.

TABLE 8.—*Comparison of patent flour from durum wheat and northwestern spring wheat of the crops of 1902 and 1903.*

TOTAL PROTEIDS IN PER CENT OF DRY FLOUR.

Durum wheat.		Northwestern spring wheat.	
Crop of 1902:	*Per cent.*	Crop of 1902:	*Per cent.*
No. 107	15.27	No. 116	14.40
103	12.64	135	13.36
109	12.52	200	13.12
115	12.38	125	12.47
Average	13.20	Average	13.34
Crop of 1903:		Crop of 1903:	
No. 240	13.40	No. 247	12.72
245	12.50	246	11.98
234	12.32		
241	12.10	Average	12.35
248	11.64	General average	13.01
202	11.36		
Average	12.22	Kansas hard winter wheat	12.85
General average	12.61	Soft winter wheat	9.57

GLIADIN–GLUTENIN IN PER CENT OF DRY FLOUR.

Crop of 1902:		Crop of 1902:	
No. 107	12.72	No. 116	12.35
109	10.89	200	11.40
103	10.76	135	11.35
115	10.53	125	10.53
Average	11.22	Average	11.41
Crop of 1903:		Crop of 1903:	
No. 240	11.02	No. 247	11.58
245	10.37	246	10.62
241	10.31		
234	10.06	Average	11.10
248	10.05	General average	11.30
202	9.76		
Average	10.26	Kansas hard winter wheat	11.00
General average	10.64	Soft winter wheat	7.89

GLUTEN IN PER CENT OF DRY FLOUR.

Crop of 1902:		Crop of 1902:	
No. 107	17.99	No. 116	13.98
103	16.42	135	13.50
115	14.18	200	13.48
109	13.16	125	12.84
Average	15.44	Average	13.45
Crop of 1903:		Crop of 1903:	
No. 240	14.36	No. 247	14.35
234	13.45	246	13.03
245	13.32		
248	13.04	Average	13.69
202	13.03	General average	13.53
241	12.38		
Average	13.26	Kansas hard winter wheat	12.64
General average	14.13	Soft winter wheat	10.51

Total proteids.—In column 2 of Table 7 and part 1 of Table 8 will be found the results for the total proteids in flour. The maximum amount found was 17.77 per cent and the minimum amount 9.05 per cent. The latter was in patent flour from soft winter wheat and the former was in a straight flour made from durum wheat grown in Russia in 1901. It will be seen that the two highest amounts of total proteids were found in flours made from this imported Russian wheat, No. 160, and the other from some wheat grown in South Dakota in 1901 from

Russian seed of the same variety, No. 166. Both of these flours were straight grade; but, allowing for a slightly greater proteid content in straight than in patent flour, the total proteids in these two samples of flour are considerably higher, with one exception, than in the other samples of durum wheat flour studied. On comparing the total proteid content of durum wheat flours of the crop of 1902 with those of the crop of 1903 (see Table 8), it will be seen that the average amount is less in 1903 than in 1902, and in both years considerably less than in flour from the crop of 1901, if judged by the single sample used, No. 166. The explanation for this distinct decrease in the amount of total proteids is without doubt the excessively wet seasons of 1902 and 1903, which would have a definite tendency to lower the proteid content of the grain. In a dry and favorable season, like that of 1901, in the case of flour No. 166 the amount of proteids is only slightly less than in the imported grain. Professor Shepard (South Dakota Experiment Station Bulletin No. 77, 1902, p. 39) found that some wheat grown in South Dakota in 1901 contained an increased amount of total proteids compared with the original imported Russian seed.

In comparing, now, the patent flour from durum wheat with similar patent flour from hard spring wheat, it will be seen that in both cases the total proteids of flour from wheat of the crop of 1902 is higher than that of 1903. The average of each year is very nearly the same for durum wheat flours as for the hard spring wheat flours, while the general average of all the samples studied is a little lower for the durum than for the hard spring, due to the fact that six samples of low-proteid durum of 1903 were included, while there were only two samples of low-proteid hard spring of 1903. The one sample of Kansas hard winter wheat patent flour has a little less total proteid than the durum. The total proteid content of soft winter wheat patent flour is, however, distinctly different from any of the three hard wheats.

Gliadin and glutenin.—The percentages of gliadin, or the proteid extracted from flour by 70 per cent alcohol, and glutenin, or the proteid insoluble in either salt solutions or 70 per cent alcohol, vary in the durum wheat patent flour from—

Gliadin, 4.64 to 7.32 per cent.
Glutenin, 4.25 to 5.45 per cent.

In the hard spring wheat patent flour the variation is—

Gliadin, 5.31 to 7.04 per cent.
Glutenin, 4.54 to 5.96 per cent.

In the Kansas hard winter wheat patent flour—

Gliadin, 6.51 per cent.
Glutenin, 4.49 per cent.

In soft winter wheat patents—

Gliadin, 3.63 to 4.42 per cent.
Glutenin, 3.41 to 4.32 per cent.

The ratios of these two proteids to each other, expressed in percentages of their sum, is given in columns 8 and 9. In the durum wheat patent flour the ratios vary from—

No. 234, gliadin, 46.12 per cent; glutenin, 53.88 per cent.
No. 107, gliadin, 57.55 per cent; glutenin, 42.55 per cent.

In hard spring wheat patent flour the ratios are—

No. 247, gliadin, 48.53 per cent; glutenin, 51.47 per cent.
No. 116, gliadin, 57.02 per cent; glutenin, 42.98 per cent.

The hard winter wheat patent flour gave—

No. 130, gliadin, 59.19 per cent; glutenin, 40.81 per cent.

The soft winter wheat patent flour gave—

No. 194, gliadin, 50.57 per cent; glutenin, 49.43 per cent.
No. 195, gliadin, 54.62 per cent; glutenin, 45.38 per cent.

On account of the properties of these two proteids and the methods at present used for their separation it is impossible to make an absolutely clear-cut separation of one from the other, and, consequently, determinations of the amounts of each and their ratios to each other vary, as is seen from the above figures, between limits that are as wide for different flours from the same class of wheat as between flours from the different classes, except perhaps between the hard wheats and the soft winter wheats. On this account it seems better to take some other factors for the comparison of flours and wheats than the separate amounts of gliadin and glutenin or their ratio to each other. While it is impossible to make a sharp separation of gliadin from glutenin, it is not so difficult to separate the two together from the other proteids soluble in dilute salt solutions. By repeated analyses of the same flours it was found that the amount of salt-soluble proteids obtained does not vary nearly so much as that of gliadin and glutenin.

If we add together the gliadin and glutenin, or if from the sum of the proteids or from the total proteids as found by nitrogen determination there is subtracted the amount of proteids soluble in salt solutions, we obtain the amount of gliadin and glutenin together. This per cent of gliadin plus glutenin in the flour (see Table 7, column 10, and Table 8, part 2) represents the amount of true gluten in the flour. The determination of gluten by the ordinary method, as shown by one of the writers in a paper read before the Association of Official Agricultural Chemists at their meeting in October, 1903, and published in the report of that meeting, is very crude and approximate so far as accurate analysis of the flour is concerned, and the desired relations are much better expressed by the factor referred to, viz, the percentage amount of gliadin plus glutenin in the flour. The results of such a determination should agree relatively with the gluten determination so far as agreement would be expected

with an approximate determination. As the amount of proteids soluble in salt solutions is quite constant, the determinations of gliadin plus glutenin will likewise agree relatively with those of the total proteid content. By consulting Table 8 it will be seen that the relative positions of the various flours in each class are practically the same for the three determinations given, viz, total proteids, gliadin plus glutenin, and gluten.

Considering now the relation between the durum wheat flour and the hard spring wheat flour, as shown by this table, it is seen that, as is the case with total proteids, so with the other two factors, the average of the 1902 wheat flour is slightly higher than that of the 1903 crop. In each case, with the exception of the gluten of the 1902 wheat flours, the agreement between the durum flour and the hard spring flour of the same season is very close, the general averages of all the determinations made of each class not being quite so close. The sample of hard winter wheat flour that was examined gave results nearly the same as those of the durum wheat flour and the hard spring wheat flour, whereas the soft winter wheat flour fell much below the others.

In general, it will be seen from both Table 7 and Table 8 that the three hard wheats gave results that approach each other oftentimes as closely as different samples of the same class, and the only flour to differ noticeably is the soft winter wheat flour. This agreement, however, is noticeable only for the seasons of 1902 and 1903. With the two flours from wheat grown in 1901, viz, No. 124 and No. 166, the results for the various proteid determinations are higher without exception in the case of the durum wheat. Therefore, while the durum wheat flour is at least equal in quality to the flour of the other hard wheats grown in the United States, and while in the case of seasons wet and otherwise unfavorable for the production of the best durum wheat, the proteid constituents agree practically with those of hard spring and hard winter wheats, yet in seasons best adapted to the growth of durum wheat the flour invariably contains a higher per cent of proteid constituents.

In regard to the water-absorbing power and the expansion of the flours, both the highest absorption and the highest expansion were with flours of durum wheats, the average of the patent flours being 65 for the durum and 62 for the hard spring wheat, the Kansas hard winter wheat flour being 62, while the soft winter wheat flours are all much lower. The average expansion for the durum wheat patent flour was 615, and for the hard spring wheat patent flour 604.

The ash content of the durum wheat flour is considerably higher than that of any of the other three classes examined, the average of the patent flours being 0.77 per cent for the durum, 0.55 per cent for the hard spring, 0.57 per cent for the hard winter, and 0.60 per cent for soft winter. This high ash content is not due to a low grade of

flour, for the ash content of the durum whole wheat is proportionally higher than that of the hard spring wheat. The average of the ash determinations of durum whole wheat was 2.14 per cent, whereas hard spring wheat gave an average of 1.62 per cent. While the sample of 1901 durum wheat flour possesses a higher ash than the average of 1902 and 1903, yet some flours of these years have as high an ash content. In this respect, therefore, the composition of the durum wheat flour, even for these wet and unfavorable years, maintains a characteristic difference from that of the hard spring wheat flours.

Conclusions.—From a careful study of the results of these investigations it appears:

(1) The total proteid content of durum wheat flour from wheat grown in Russia and from that grown in this country in normal seasons is considerably higher than that in any of the other principal classes of American wheats.

(2) In durum wheat grown in the United States in wet and otherwise unfavorable years the proteid content falls to an amount about equal to that of northwestern hard spring wheats or Kansas hard winter wheats, but is above that of the soft winter wheats.

(3) On the average the proteid content of durum wheat flour grown in 1902 or 1903 is equal to that of northwestern hard spring wheat of the same year, but in flour made from normal wheat grown under more favorable conditions it is higher.

(4) The amount of gliadin plus glutenin in the flours from the typical wheats studied is in practically the same relation as the total proteids just described.

(5) The absorption and expansion are, as a rule, greater in the case of flour from durum wheat than of flour from hard spring wheat or hard winter wheat.

(6) The ash content of durum wheat patent flour is considerably higher than that of hard spring wheat patent flour.

(7) In general, durum wheat flour differs in composition from hard spring wheat flour in having larger amounts of proteids, ash, and sugar,[a] but in unfavorable seasons having too much moisture some of these fall to about the same amount as found in the other hard wheats.

EXAMINATION OF THE FLOUR AND BREAD OF THE BAKING TEST.

The analyses of the two flours used in the baking test and of the breads made from them will now be considered.

In the preceding tables (7 and 8) of flour analyses, No. 115 is the flour used in the bread test for bread X and No. 116 is the flour used for bread P. These will be called hereafter "flour X" and "flour P," corresponding to bread X and bread P.

From an examination of these tables it will be seen that in regard to the proteid constituents flour P is above the average of the patent

[a] See examination of the flour and bread of the baking test, p. 48, and Table 12.

flours from northwestern hard spring wheat, the same being true also of the absorption and expansion. On the other hand, flour X is about equally below the average of 1902 durum wheat patent flours. being about equal to the general average for the two years 1902 and 1903. The two flours X and P, however, are not further apart on these points than are the extremes of either the hard spring wheat patent flours or the 1902 durum wheat patent flours. The two flours are in fact the opposite extremes of their respective classes in regard to proteid constituents, and practically so as to expansion and absorption.

The doughs for the two lots of bread were made according to the following formulæ:

TABLE 9.—*Formulæ for doughs used in baking test.*

Material.	Dough for X.		Dough for P.	
	As weighed.	As dry matter.	As weighed.	As dry matter.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Flour	167	146.4	196	170.9
Water	86	----------	101	----------
Milk	42	5.4	50	6.4
Sugar	5.5	5.5	6.5	6.5
Salt	4	4	4.75	4.75
Lard	4.75	4.75	6	6
Yeast	1.25	a1.25	1.5	a1.5
Total ingredients	310.5	167.3	365.75	196.05

a Approximate.

The milk was not analyzed, but considering an average milk to contain 12.8 per cent total solids, of which 3.7 per cent is fat and 4.9 per cent milk sugar, the amount of dry matter and the amount and per cent (calculated on dry matter) of each ingredient are given in Tables 9 and 10.

TABLE 10.—*Amounts and percentages of the ingredients of breads X and P.*

Ingredient.	Bread X.		Bread P.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Amount of liquid to 100 parts of air-dry flour	----------	77	----------	77
Dry matter in dough	167	53.8	196	53.6
Flour (per cent of total ingredients)	167	53.8	196	53.6
Cane sugar	5.5	3.29	6.5	3.31
Milk sugar	2.06	1.23	2.45	1.25
Fat in milk	1.55	.93	1.85	.94
Fat as lard	4.75	2.84	6	3.06
Salt	4	2.4	4.75	2.42
Yeast	1.25	.74	1.5	.76

From this table it is seen that the various ingredients of the bread were used in almost exactly the same proportions. The amounts used in the case of the bread P were those found by long experience to produce the best bread from flour P, so that every condition was the best for this flour. In order to have the two breads exactly comparable, and the bread X tested in comparison with a standard loaf, these conditions, known to be the best for bread P, were followed for both breads. This would unquestionably be to the advantage of the

standard bread, but would give accurate comparative results as desired. The only conditions modified were the time of mixing, the fermentation period, and the time of baking. These were changed slightly, as considered best for the doughs, by the expert bakers in charge of the baking. The advantage in having the ingredients of both breads exactly the same is that both the loaves themselves and the results of the analyses are directly comparable.

Three loaves of each bread were taken for analysis, the loaves being in each case an average of the entire lot. Two of these loaves (one of each kind), after weighing and measuring, were cut and analyzed 14 hours after they were taken from the oven. (See Pl. IV, fig. 1.) Two other loaves were similarly treated 68 hours after baking, being kept in the meantime in an ordinary room, simply wrapped in paper.

The third pair of loaves was kept under the same conditions until 158 hours after baking, when they were also cut and analyzed. The following table shows the weight, volume, and moisture relations as determined on each of the six loaves:

TABLE 11.—*Weight, volume, and water content of bread in baking test.*

[Bread baked April 27, 1903, 8 p. m.]

Time of weighing and analyzing.	Bread X.				Bread P.				Difference between water in X and P.
	Weight.	Volume.[a]	Loss in weight.	Water in loaf when cut.	Weight.	Volume.[a]	Loss in weight.	Water in loaf when cut.	
First loaf:	*Grams.*		*Per ct.*	*Per ct.*	*Grams.*		*Per ct.*	*Per ct.*	*Per ct.*
14 hours after baking	425.3	306.4		38.12	428.7	313.2		36.76	1.36
Second loaf:									
14 hours after baking	437.2	300.7			431.3	301.4			
68 hours after baking	427.7		2.17	35.61	422.3		2.10	34.42	1.19
Third loaf:									
14 hours	440.8	293.6			410.4	293.6			
68 hours	432.3		1.94		402.0		2.04		
92 hours	414.6		4.01		384.8		4.13		
116 hours	404.5		2.30		374.8		2.44		
140 hours	397.0		1.63		367.3		1.83		
158 hours	390.5		1.48	29.11	360.7		1.62	28.20	.91
Total			11.42				12.11		
Average	[b]434.4	300.2	[c]1.73		[b]423.4	302.7	[c]1.82		1.20
Ratio of average weight to average volume	1.44				1.39				

[a] The figures given here indicate relative, not actual, volumes of the loaves. The distances around the loaf lengthwise and crosswise are found by measurement, and these multiplied together give the so-called volume.
[b] Average of weights taken at 14 hours after baking.
[c] Average loss of weight in third loaf for each 24 hours.

While the average weight of a loaf of bread X is slightly greater than that of bread P, the loaf volume of X is nearly the same as that of P. This makes the ratio between the weight and volume of the loaf larger in the case of bread X than of bread P. This means that bread X is somewhat more solid than bread P, or weighs more per cubic inch. This is largely accounted for by considering the percentage of moisture in the bread, X having on an average 1.2 per cent

more moisture than P, and does not mean that X is what would be called heavy, as is seen by the answers to question No. 4 on the circular letter sent with the bread. (See page 49.) The texture of bread X is on an average fully equal to that of bread P. In connection with this point it will be seen that the average loss of water in 24 hours, by standing in the air, is less in X than in P. This would indicate that the reason for the greater weight per unit volume of bread X is because the moisture is not only more in actual per cent, but is given up at a slower rate than with bread P. As shown in the next table, the absorption of flour X is likewise slightly more than of flour P.

TABLE 12.—*Comparative analyses of flour and bread made from durum wheat and northwestern spring wheat.*

Determination.	Flour.		Bread.	
	X	P	X	P
Average weight.....grams			434.40	423.40
Average loaf volume			300.20	302.70
Loss of weight in 158 hours			11.42	12.11
Average loss in weight per 24 hours			1.73	1.82
Water.....per cent	12.31	12.80	38.12	36.76
Acidity as lactic acid.....do	.13	.19	.39	.31
Ash.....do	.80	.57	3.29	3.00
Fat.....do	.33	.43	3.96	3.53
Fat added.....do	3.77	4.00		
Invert sugar.....do			3.77	3.55
Cane sugar.....do			1.43	1.03
Total sugar (soluble carbodydrates).....do	1.54	1.03	5.20	4.58
Cane sugar added in baking.....do	3.29	3.31		
Milk sugar added in baking (calculated from milk).....do	1.23	1.25		
Proteids soluble in salt solution.....do	1.90	1.82	.62	1.12
Proteids soluble in 70 per cent alcohol at 25°–30° C.....do	5.70	7.05	1.48	1.59
Insoluble proteids.....do	4.83	5.31	[a]10.33	[a]10.52
Total proteids.....do	12.38	14.40	12.43	13.23
Heat of combustion per gram of dry matter[b].....calories			4,452 4,442	4,426 4,420
Absorption (cubic centimeters of water per 100 grams of flour)	67 68	66		
Expansion (in cubic centimeters per 100 grams of flour)	600	620		

[a] By difference.

[b] The determinations of the heat of combustion were made by Mr. E. M. Chace, of the Bureau of Chemistry.

In Table 12 will be found the complete analysis so far as made of the two flours and of the two breads. The results are placed together in one table in order that an easy comparison may be made not only of the breads but also of the flours, and of the flours with the breads made from them. The acidity expressed in terms of lactic acid is slightly more in flour P than in flour X, whereas the acidity of bread P is less than that of bread X. This shows that the fermentation went a little further in bread X than in P. It will be seen by reference to Table 10 that the amount of salt used was slightly less in X than in P, thus tending to shorten the fermentation in P in comparison with that of X.

The ash content of the two flours is noticeably different, being much higher in flour X than in flour P. The ash of flour P is 0.57 per cent, being slightly above that of a corresponding Minneapolis patent flour, while the ash of flour X is 0.8 per cent. As would be

expected, the ash of bread P is smaller than that of bread X. The increase in ash of the bread over that of the flour from which it was made is almost exactly accounted for by the salt and other mineral matter introduced. The agreement is not so close in the relation between the fat in the two breads and the fat in the flours plus the added quantity used in making the bread. Only one loaf was analyzed, however, for these two factors, whereas in the other cases three loaves of each kind were analyzed, and the results given in the tables are the averages of those obtained.

It is interesting to note that the sugar content of the two flours is considerably different, considering the small amount of sugar (invert sugar and cane sugar) present in flour. It was found from the analyses of several durum wheat flours that in general they contained a noticeably larger amount of total sugars (soluble carbohydrates) than ordinary wheat flours. About the same difference in sugar content is found in the breads as in the flours, the same relative amounts of sugar being added to each flour in making the bread. This fact was generally noticed by those who tasted the bread, many of the answers to question 2 (see p. 49) being that bread X was sweeter.

In regard to the proteid constituents of the flours and breads, as would be expected, the proteids soluble in alcohol and in salt solution are much lower in the bread than in the flour, due of course to the change in the proteids during fermentation and baking.

Finally, in regard to the food value of the breads as measured by the determination of the heat of combustion, there is a difference in the heat of combustion of the two breads of about 34 calories, which would mean approximately an equivalent of less than 0.01 gram of sugar or 0.006 gram of proteids in 1 gram of bread, which is too small to be of importance. The food values of the two loaves of bread, therefore, are as nearly the same as could be expected. In fact the heat of combustion of two corresponding loaves of bread made from these same flours the week preceding the final test was 4,462 calories for bread X and 4,434 calories for bread P, showing almost as much difference between two loaves from the same flour as between those from the different flours.

Conclusions.—From the preceding chemical examination of the bread made from durum wheat flour, in comparison with similarly made bread from hard spring wheat flour, the following conclusions seem justified:

(1) Durum wheat flour produces a bread that, as a rule, contains slightly more moisture and loses this moisture at a slower rate than bread made from hard spring wheat flour.

(2) The average weight of loaves of equal loaf volume is slightly greater in the case of durum wheat flour than of flour from hard spring wheat.

(3) The average loaf volume of loaves scaled to the same weight when molded is almost the same with the two kinds of flour.

(4) Durum wheat flour and the bread made from it contain noticeably larger amounts of sugar than hard spring wheat flour or bread.

(5) The ash content of durum wheat flour and bread is greater than that of hard spring wheat flour or bread.

(6) The food value of the two kinds of bread, as measured by the heat of combustion, is practically the same.

REPORTS ON TRIALS OF THE BREAD.

The baking was conducted on a sufficiently large scale to produce more than 250 loaves from each flour. This was done in order that the experiment might be conducted in a practical way, just as ordinary commercial bakings, and therefore be of much greater value to the trade generally, and also in order that an opportunity could be given for a complete series of table tests of the bread by many people in different parts of the country. When the bread was made, two loaves, one of the durum wheat and one of the hard spring wheat flour, were sent to each one of 200 persons living outside of Washington, D. C., and to about 40 people in Washington, D. C., for inspection and report as to their relative merits. A reproduction of the circular letter accompanying each set of loaves is here given, in which it will be seen that there was no intimation whatever of the bakery with which the Department cooperated in the experiments nor of the nature of the flour from which the loaves were made, it merely being stated that they were made under exactly the same conditions from two different flours.

[Copy of circular letter.]

WASHINGTON, D. C., *April 27, 1903.*

DEAR SIR: The accompanying two loaves of bread, marked "P" and "X," were made in cooperation with a large bakery under exactly the same conditions, but from different flours. To aid us in carrying out an important experiment, will you kindly give us your opinion of the relative merits of the two loaves by answering the questions given below and adding your name and address in the spaces provided? Then inclose the sheet in the return envelope and mail promptly to this Department, no postage being required.

Very truly yours,

M. A. CARLETON,
Cerealist.

Approved:

A. F. WOODS,
Pathologist and Physiologist.

1. Which loaf is fresher?
2. Which has the better flavor?
3. Which has the better color?
4. Which is better in texture?
5. Which is moister?
6. Which has a better crust in color and taste?
7. Which do you consider to be more nutritious?
8. On the whole, which one is the better loaf of the two, and why?

Remarks:

Name.

Address,

4876—No. 70—04——4

The persons to whom the loaves were sent for inspection were carefully selected and include the most prominent millers, bakers, flour inspectors, chemists, and teachers of domestic science. A consensus of the opinions of these persons ought therefore to be quite reliable and authoritative. In a number of cases the persons were apparently much interested in the subject and voluntarily gave certain information not asked for in the circular letter. Over 200 replies were received to this circular letter, a greater number than was expected. The promptness exhibited in answering the letters was also very gratifying. A summary of these reports is interesting.

Out of the total number of persons answering question No. 1, Which loaf is fresher? 100 answered in favor of X, or the durum wheat loaf; 60 in favor of P, and 39 thought there was no difference. Concerning question No. 2, Which has the better flavor? 143 answers were favorable to X, 70 to P, and 4 thought they were equal.

Concerning question No. 3, Which has the better color? as was to be expected, quite a small minority of answers was favorable to X, there being only 37, while 150 favored P, and 3 thought the color was equally good in each. As to question No. 4, Which is better in texture? 103 decided for X, 84 for P, 14 others thinking there was no difference in texture.

As to the question, Which is the moister? 134 decided in favor of X, 53 in favor of P, and 17 thought there was no difference. Question No. 6, Which has the better crust in color and taste? brought various answers. In general 78 were in favor of X, 85 in favor of P, and 21 thought there was no difference. As a matter of fact, however, many of the answers were divided, as one might have supposed, saying, usually, that in X the taste was better and in P the color was better.

In asking question No. 7, Which do you consider to be more nutritious? it was not expected that an accurate answer could always be given, though it was supposed that in some cases analyses would be made, but simply from previous association it was thought that each one might have some idea as to the better nutrition of the one or the other. Naturally, therefore, many did not answer this question. Of the answers given 106 favored X, 35 favored P, and 2 thought there was no difference.

Finally, as giving the general weight of opinion favorable to one loaf or the other, 108 persons answered question No. 8 in favor of X, 74 in favor of P, and 2 answered that there was no difference. *The general opinion, therefore, of the relative value of the durum wheat loaf as against that made from other flour is 108 to 74 in favor of the durum wheat loaf.* As already observed, however, in two particular characters, namely, that of color and that of color and taste of the crust, the answers were unfavorable to the durum wheat loaf; in all other characters the answers were in a large majority of cases in favor of the X loaf.

As a number of tests made by ourselves in the Department and preliminary trials made by the establishment which did the baking seemed to show rather conclusively that the particular grade of durum wheat flour used in this test was quite inferior to flour of the same class of wheat used before, it is extremely interesting and rather remarkable that the general weight of opinion of these competent persons concerning the merits of the two loaves should be so decidedly in favor of the X or durum wheat loaf.

To show the authoritative nature of these reports on the samples of bread distributed, it will be proper to give a list, as follows, of the names and addresses of persons to whom the bread was sent for examination and from whom replies were received. The list is classified in accordance with the occupation of each person reporting. There are omitted from the list quite a number of names of people who were either well acquainted with the circumstances accompanying the baking test or whose experiences have not been such as to qualify them for being good judges in the matter.

Following is the list:

Grain dealers:

John H. Wrenn & Co., Chicago, Ill.
Van Dusen-Harrington Company, Minneapolis, Minn.
Fyfe, Manson & Co., Chicago, Ill.
H. Poehler Company, Minneapolis, Minn.
Knight, Donnelley Company, Chicago, Ill.
Barnum Grain Company, Minneapolis, Minn.

Millers:

W. B. Dunwoody, Joplin, Mo.
C. Hoffman & Son, Enterprise, Kans.
Sorenson & Son, Tower City, N. Dak.
Canadian County Mill and Elevator Company, Elreno, Okla.
Hougen Milling Company, Northwood, N. Dak.
Crosby Roller Milling Company, Topeka, Kans.
Bowersock Milling Company, Lawrence, Kans.
Omaha Milling Company, Omaha, Nebr.
Aberdeen Mill Company, Aberdeen, S. Dak.
Newton Milling and Elevator Company, Newton, Kans.
Lincoln Mill Company, Lincoln, Nebr.
Wells, Abbot & Nieman, Ord, Nebr.
R. J. Edwards, Bunker Hill, Kans.
Farmers' Mill and Grain Company, Milnor, N. Dak.
Swanson & Larson, Fessenden, N. Dak.
Hastings Milling Company, Hastings, Nebr.
La Junta Milling Company, La Junta, Colo.
Henry Lohse & Bro., Elsie, Nebr.
Charles Schreiner, Kerrville, Tex.
Russell-Miller Milling Company, Minneapolis, Minn.
Sheffield-King Milling Company, Minneapolis, Minn.
Washburn-Crosby Company, Minneapolis, Minn.
F. K. Wing, Ipswich, S. Dak.
George C. Christian, Redfield, S. Dak.
Fargo Roller Mill Company, Fargo, N. Dak.
Arlington Mill Company, Arlington, S. Dak.

Millers—Continued.
Honey Brothers, Park River, N. Dak.
I. R. Andrews, Indianola, Nebr.
Missouri Valley Milling Company, Bismarck, N. Dak.
Moses Brothers Mill and Elevator Company, Great Bend, Kans.
Burlington Roller Mills, Burlington, Colo.
New Century Milling Company, Dallas, Tex.
I. M. Yost Milling Company, Hays, Kans.
M. Braun & Co., Wahpeton, N. Dak.
Cain Mill Company, Atchison, Kans.
Cando Roller Mills, Cando, N. Dak.
E. X. Knight, Pierpont, S. Dak.
Wagner Milling Company, Milbank, S. Dak.
L. F. Campbell, Norcatur, Kans.
Kampeska Milling Company, Watertown, S. Dak.
J. W. Kelley & Son, Huron, S. Dak.
Imboden Milling Company, Wichita, Kans.
Lamar Mill and Elevator Company, Lamar, Colo.
York Roller Mills, York, Nebr.
W. C. Leistikov, Grafton, N. Dak.
Elreno Mill and Elevator Company, Elreno, Okla.
Hay Springs Milling Company, Hay Springs, Nebr.
Pueblo Flour Milling and Elevator Company, Pueblo, Colo
Abilene Mill Company, Abilene, Tex.
George P. Sexauer, Brookings, S. Dak.
New Era Milling Company, Arkansas City, Kans.
Inter-Ocean Mills, Topeka, Kans.
Walnut Creek Milling Company, Great Bend, Kans.
Texas Star Flour Mills, Galveston, Tex.
Ellendale Milling Company, Ellendale, N. Dak.
Charles L. Hyde, Pierre, S. Dak.
Crescent Mill and Elevator Company, Denver, Colo.
Oakes Milling Company, Oakes, N. Dak.
W. J. Alsop, Beloit, Kans.
Hungarian Milling and Elevator Company, Denver, Colo.
Werkheiser-Polk Mill and Elevator Company, Temple, Tex.
Cameron Mill and Elevator Company, Fort Worth, Tex.
E. W. Kirkpatrick, McKinney, Tex.
David B. Kirk & Co., Kansas City, Mo.
Diamond Milling Company, Grand Forks, N. Dak.
Gunther Milling Company, San Antonio, Tex.
Lee-Warren Milling Company, Salina, Kans.
Foulds Milling Company, Cincinnati, Ohio.

Bakers:
August C. Junge, Joplin, Mo.
Fleischmann's Vienna Model Bakery, New York, N. Y.
Ward-Mackey Company, Pittsburg, Pa.
Atlas Bread Company, Milwaukee, Wis.
C. H. Burke Baking Company, Nashua, N. H.
S. C. Billings, Valparaiso, Ind.
Fraser & McMillan, Burlington, Vt.
Gordon Smith, Mobile, Ala.
J. F. Whiteside, Louisville, Ky.
Joseph Reuther, New Orl ans, La.
E. A. Dexter, Springfield, Mass.

Bakers—Continued.

B. Howard Smith, Kansas City, Mo.
George Rushton, Rosedale, Kans.
O. G. Marjenhoff, Charleston, S. C.
H. Korn & Sons, Davenport, Iowa.
A. A. White, Baltimore, Md.
J. W. Swint, East Boston, Mass.
Ferguson Eros., Boston, Mass.
C. F. Hathaway, Cambridge, Mass.
Charles Trefzger, Peoria, Ill.
Ohio Baking Company, Cleveland, Ohio.
Charles W. Kolb, Philadelphia, Pa.
Frank R. Shepard, Charlestown, Mass.
Collins Baking Company, Buffalo, N. Y
T. W. Russell, Binghamton, N. Y.
P. Schmidt, Baltimore, Md.
John E. Endlich, Port Huron, Mich.
Morton Baking Company, Detroit, Mich.
S. S. Thompson & Co., New Haven, Conn.
Freihofer Vienna Baking Company, Philadelphia, Pa
Campbell-Sell Baking Company, Denver, Colo.
John Schneider's Son & Co., Cincinnati, Ohio.
A. A. Du Bau, Philadelphia, Pa.

Teachers and experts in domestic science:

Prof. Jane A. L. Zabriskie, College of Agriculture, State University, Columbia, Mo.
Prof. Abby L. Marlatt, Manual Training School, Providence, R. I.
Mrs. Nellie Kedzie-Jones, Berea, Ky.
Prof. Anna M. Gilchrist, Agricultural College, State University, Knoxville, Tenn.
Prof. Gertrude Coburn, Bradley Polytechnic Institute, Peoria, Ill.
Miss Maria Parloa, 204 West Eighty-third street, New York, N. Y.
Prof. Isabel Bevier, State University, Urbana, Ill.
Miss Florence R. Corbett, supervisor of domestic science, Kings County Hospital, Brooklyn, N. Y.
Miss Emma S. Jacobs, Manual Training School, Washington, D. C.
Prof. Edith A. McIntyre, Agricultural College, Manhattan, Kans.
Prof. Maude M. Gardiner, Agricultural College, Stillwater, Okla.
Miss Fannie M. Farmer, School of Cookery, Boston, Mass.
Prof. Ellen H. Richards, Massachusetts Institute of Technology, Boston, Mass.
Miss Sophronia Maria Elliott, Simmons College, Boston, Mass.
Prof. Susan M. Reid, Agricultural College, Fargo, N. Dak.
Prof. Minnie A. Stoner, College of Agriculture, State University, Columbus, Ohio.
Miss Lillian M. Wilson, Tome Institute, Port Deposit, Md.
Mrs. Mary J. Lincoln, editor American Kitchen Magazine, 28 Oliver street, Boston, Mass.
Mrs. Sarah T. Rorer, Philadelphia Cooking School, 1715 Chestnut street, Philadelphia, Pa.
Prof. Juniata L. Shepperd, Agricultural College, St. Anthony Park, Minn.

Chemists and flour experts:

Dr. H. W. Wiley, Department of Agriculture, Washington, D. C.
C. E. Foster, flour expert, Consolidated Milling Company, Minneapolis, Minn.
Prof. Harry Snyder, Agricultural College, St. Anthony Park, Minn.

Chemists and flour experts—Continued.
John H. Julicher, flour expert, Pillsbury-Washburn Flour Mills Company, Minneapolis, Minn.
Prof. J. H. Shepard, Agricultural College, Brookings, S. Dak.
Prof. E. F. Ladd, Agricultural College, Fargo, N. Dak.
Prof. J. T. Willard, Agricultural College, Manhattan, Kans.
Technical journals:
Roller Mill, Buffalo, N. Y.
Modern Miller, St. Louis, Mo.
Baker's Helper, Chicago, Ill.
American Miller, Chicago, Ill.

Of the six grain dealers reporting four considered the durum wheat loaf X to be the better, while the other two favored the hard spring wheat loaf P.

The number of millers to whom the samples were sent was larger than that of any other class. As would be expected, particularly with a new grain, the majority of the millers favored the loaf P, the result standing 38 to 25 in favor of P, while a number gave no decided opinion either way. In the face of much opposition by many millers to the durum wheat up to that time, it is a surprise that there should be so small a majority in favor of the loaf P, unless it be that such opposition was not well founded. It is of interest to note also that a large number of those deciding against the loaf X are millers residing in the soft winter wheat district. On the other hand, a large number of those favoring the loaf X are millers of hard winter wheat.

Of the bakers to whom samples were sent, 33 made reports, 18 deciding in favor of the loaf P, 13 favoring the loaf X, and 2 giving no decided opinion. Here again the majority in favor of the loaf P is not nearly so large as one would expect in consideration of the decided preference among bakers generally for a white flour and a white loaf. It is a fact of the utmost importance that in the reports of both the bakers and the millers, if one were to leave out entirely the one quality of color, there would be a very large majority decidedly in favor of the loaf X, it being so much better in all other important points. In very many instances the statement was made that while the party personally preferred the loaf X, and that in all essential points it was really the better, yet commercially the loaf P would be better. As the important thing with the baker or miller is, of course, the money value of the flour or bread, these reports were all set down as in favor of the loaf P, though, as a matter of fact, judging from the intrinsic value, the decision would really be in favor of the loaf X. When we consider, as discussed later on, the relative nature of the quality of color—it being so easy to produce a loaf whiter or more yellow as one chooses—the conclusion is inevitable that the reports of even the bakers and millers, who are the persons most concerned in handling the wheat, are, as a matter of fact, overwhelmingly in favor of the X loaf.

Now we come to the class of people who are perhaps really more

competent to give exact opinions of the relative value of the two kinds of bread than any of those already mentioned, namely, the teachers and experts in domestic science, since they are not influenced from the financial standpoint and therefore do not consider seriously the trade value of the comparatively unimportant quality of color. At the same time they have studied carefully both what is actually wanted in the home from the standpoint of attractiveness and taste and also the actual dietetic value of different kinds of bread. It is significant, therefore, to note that of the 20 persons of this class reporting upon the samples 12 decided in favor of the loaf X and 4 in favor of the loaf P, while the remaining 4 gave no decided preference, making a majority of 4 in favor of the loaf X out of the entire number reporting.

Of the 7 chemists and flour experts reporting 2 gave an opinion simply upon the household use of the bread without regard to the technical qualities of the two kinds, and their answers are, therefore, not reckoned, although they were in favor of the loaf X. Of the remaining five, 3 decided in favor of the loaf X and 2 in favor of the loaf P.

Of the technical journals reporting 2 favored the loaf P, 1 the loaf X, and the fourth gave no decided preference.

Quotations from particularly interesting reports.—It will now be well to give in detail some of the reasons for deciding in favor of the loaf X on the part of a number of those who so reported. First, answers from two of the grain dealers will be noted, one stating that X is the better of the two loaves because it "is lighter and not so soggy as P, and is apparently made better; P has not the life of X." The other answers that "there is a marked difference, as indicated above, in favor of X. I eat bread for pleasure and not as a medicine. X is delicious; P is not."

Some of the answers from millers are as follows: (1) "X is better on account of being fresher and moister and has the better flavor, while P is whiter and has a better crust. Neither of the loaves seems to be made from Kansas hard winter wheat flour, as they lack the nutty, sweet taste." (2) "X has retained moisture better, has thinner crust and better flavor, and is one-half ounce heavier, which, if the same amount of flour was used, is in its favor. Would judge that X is made from hard wheat and P from soft. Are we correct?" (3) "X has better strength and is more nutritious. My opinion is that the loaf marked X is made from hard winter wheat. Would you kindly inform me how near I am correct?" (4) "X is better. We judge it is made of hard wheat, while P is made of soft wheat."

We quote from reports of the bakers as follows: (1) "X is better because it is better in all the points but color and will keep longer than P." (2) "X is the better loaf; flour should be tried without shortening of any kind; flour, yeast, salt, and water only should be used. P makes a larger loaf, and by the proper experiment (?) in

baking might be of greater commercial value to the baker." (3) "X would sell better, because of a rich appearance; looks like a good spring wheat, while P looks like a winter wheat. P would not give so good a yield; would not take as much water." (4) "X is the better if you eat with your palate; P if you taste with your eyes." (5) "X is more even and better molded; better fermentation. A straight dough with less fermentation would improve this loaf, it seems to us." (6) "I think X is better because it has more body." (7) "We find X the better loaf of the two, being fresher, moister, and better in flavor, color, texture, and in color and taste of the crust."

A teacher of domestic science answers the questions in the circular letter as follows, viz: "(1) 'P.' (2) 'X' has rich nutty flavor, while 'P' tastes sour. (3) 'X;' ('P' is more nearly white). (4) 'X' has fine, even-sized cells; walls elastic. (5) 'P.' (6) 'X' is smooth, firm, and sweet. (7) Answer must be a guess—'X.' (8) 'X,' in my judgment, is the better loaf, in flavor being nutty and not coarse in texture. The question of color is not so important as flavor and texture, therefore, though 'P' is more nearly white, I prefer the yellow-white hue of 'X.'"

A second teacher, in answer to question No. 8, says: "'X,' because the grain is finer and more uniform, the texture firmer and more elastic, the flavor sweeter and more satisfactory, and has evidence of being a better mixed dough. Crumb when rolled between fingers does not pack as 'P' does."

A third teacher says: "'X' is better; it is an evenly porous, moist loaf with a decided but not objectionable flavor. Loaf 'P' is lighter in weight but larger in bulk than loaf 'X.' 'P' weighed 15 ounces light; 'X' 15¼ ounces heavy, due probably to loss of moisture, as 'P' is drier."

Another teacher, a well-known writer in domestic science, says: "'X' is better, because it will wear better; will require less addition of butter or jam to make it palatable."

Another says: "'X' is better, because the texture is finer, showing more even distribution of gas and less coarse; more of wheat present, giving color, flavor less like sawdust. Better baked, less salvy or clammy."

Another states that "'X' is better, as it seems to have more substance and is less dry and less chippy than 'P.'"

The following reports from two of the chemists and flour experts have already been made public through correspondence in the Northwestern Miller (see issue of October 7, 1903), and are here reproduced as follows, viz:

Report No. 1.

Question No. 1. No apparent difference when received May 1: X showed higher moisture content.

Question No. 2. X seemed to hold its flavor better.

Question No. 3. P, white; X, slight yellow tinge; X, better color.

Question No. 4. X.

Question No. 5. Water—May 2, 1903—3 p. m., X showed 33.40 and P 32.80 per cent.

Question No. 6. X.

Question No. 7. Can not be told from inspection.

Question No. 8. X, more normal loaf, better fermentation development: P, crust more like a cracker.

Remarks: Total proteids (on dry matter)—X, 13.01 per cent; P, 13.67 per cent. Ash and salt—X, 2.23 per cent; P, 2.04 per cent. Weight when received May 1, 1 p m.—P, 388.50 grams, 42.20 per cent water; X, 434.40 grams, 43.60 per cent water. Size of loaf—P, 14½ by 20½ inches; X, 14½ by 20¼ inches (one corner low).

Report No. 2.

Question No. 1. X loaf is perfectly sweet; P loaf is musty.

Question No. 2. X has the better flavor.

Question No. 3. P is the whiter; X is creamy white, an indication of high quality.

Question No. 4. P loaf has the better texture.

Question No. 5. P loaf, 44.79 per cent water; X loaf, 44.58 per cent water.

Question No. 6. X loaf is decidedly the better.

Question No. 7. X loaf not analyzed; X, 13 per cent proteids only; P, 14.04 per cent proteids.

Question No. 8. X loaf appears to have been made from spring wheat flour of good quality. P loaf is a blend of spring and winter wheat flour. A gray white in the loaf is the indication of inferior quality in flour. X loaf shows that fermentation has not been continued long enough to destroy the nutritious elements.

Remarks: A little explanation is due, as I started to fill out your blanks before thorough investigation. The X loaf has 2.26 per cent salt, and P 2.02 per cent. X has 44.58 per cent moisture, and P 44.79 per cent, so it is clear that fermentation had not proceeded as far in X as in P, being retarded by extra salt and a tighter sponge. The proteids being higher in the P loaf seems to spoil my assertion on blank as to nutrition; however, conditions being equal, I should claim same preference.

In size X equals 25.10 by 15.45 inches; P equals 24.90 by 15.10 inches. Color of X yellow white, texture fair, flavor good. Color of P, gray white; texture, good; flavor, flat(?) musty.

It will be of further interest to quote portions of the reports of others who really decided against the loaf X, because of certain significant statements made or because of the general importance of the remarks. An answer of one of the milling journals is that "P is the better loaf commercially, because whiter and it looks lighter, but X would satisfy the family better where home baking is carried on." One of the best-known writers on cooking and domestic science, after filling out the report, comments as follows:

I suppose you realize that bread made as were these two loaves does not give the best results. If the bread was not risen so much, was made in smaller loaves, and was baked more thoroughly, giving less crumb and more crust, I am inclined to think that X would lose that wild taste and come out of the oven a sweet, nutty loaf. Could you not have the flours tried with real French bread or family bread made in small loaves and thoroughly baked? It is wonderful the difference that the shape and size of the loaf and the baking makes in the flavor of the wheat.

Of course it is understood also that the dough shall not be raised so much as to destroy the fine flavor of the wheat. As a nation we need to learn the value of the small loaf, not too much risen and thoroughly baked at a fairly high temperature.

A well-known baking company in Philadelphia comments as follows: "P is the better loaf because of the fact that the loaf marked X was taken before given proper proof. It is our opinion that had the dough of the loaf marked X had proper proof—that is to say, a little more proof—it would have made the better loaf of bread."

Another prominent baking company states that "the loaf marked 'P' is the better loaf of the two. The loaf marked 'X' seemed to be richer in sugar and fat. The color of the crumb in 'X' is too yellow or creamy and that of 'P' could be a little more creamy. A little less sugar and shortening in baking the 'X' flour might give the same results as in the 'P.'"

A New York baker writes: "P is the better loaf, because of its pure milk ingredient as against the greasier shortening in X."[a]

A Texas milling company says that "P has the better appearance and smells and tastes more natural. Both loaves are very good bread, but X tastes and smells like bread made from very hard wheat flour."

Another Texas milling company writes that "P is the better loaf, because it is more moist, having a flavor similar to bread made with milk. It is whiter and better developed. The loaf X seems to be made of a strong hard wheat flour, which makes a large loaf, but dries quickly when exposed to air." (See Table 11.)

A North Dakota milling company makes the following rather interesting comment:

P is the better loaf. These two loaves are just like two we had on a test from macaroni flour and Bluestem flour. In our test we found the Bluestem flour made somewhat the larger loaf and weighed a little more. I think X is made from macaroni flour and will hold moisture longer. Macaroni wheat will not make as much flour per bushel, though, by 5 pounds.

RESULTS OF OTHER TESTS.

Other bakeries in Washington, D. C., made trials of the durum wheat flour for bread with results rather similar to those obtained in the large baking tests already described. A considerable amount of durum wheat flour milled by another prominent milling company in Minneapolis was afterwards obtained by the Department of Agriculture and distributed to several bakeries and also to a number of families. Some of this flour was used in another baking test by the firm which cooperated in the tests described in this bulletin, and the results were even more satisfactory than in previous tests. This flour appeared to be the best that had yet been used in any of the baking tests with

[a] As a matter of fact, the same kinds and amounts of ingredients, proportionally, were used in both cases. (See Table 10.)

which the Department was concerned. A chemical examination of this flour was made along with other flours and is reported in the preceding chapter on that subject. (The bread from this second flour is illustrated in Plate V.)

During 1903, a number of experiments were made by Prof. George L. Teller, of Chicago, in the use of durum wheat flour for bread in comparison with other flours. As one of these series of experiments is particularly interesting and bears closely upon the subject under discussion, it will be desirable to quote the published results from the American Miller of October, 1903. Professor Teller published these results under the title "Flour from Macaroni Wheat." A portion of the article is here presented as follows:

In these experiments the macaroni wheat flour was used in connection with one of the best known brands of Minneapolis spring wheat patent flour purchased from a large grocery in Chicago. Being used as a basis of comparison in the report it is called "standard flour." The other flours are shown in the report by numbers, and are as follows:

No. 1 is a sample of pure macaroni wheat flour.

No. 2 is a flour produced by blending one part of macaroni wheat flour with two parts of the standard flour.

No. 3 is the same as No. 2, except that instead of mixing the two flours in the dry before making them into bread the macaroni was first made into a sponge, and when the sponge had properly developed the remaining flour (the standard spring patent) was added to complete the dough.

Comparative results.

	Standard spring patent.	No. 1.	No. 2.	No. 3.
Gluten, per cent	11	10.8	10.9	10.9
Ash, do	.42	.52	.45	.45
Absorption, do	62	63	62	62
Color	100	98	99.3	99.3
Loaves, per barrel	100	100.6	100	100
Size of the loaf	100	94.8	94.8	100
Quality of the loaf	100	99	100	100
Average value	100	98.1	98.5	99.8

The macaroni wheat flour has a much higher ash and a little lower gluten than the standard. The absorption is 1 per cent more, but the flour was enough drier to make them ordinarily about equal in this respect. The color, though of a very dark shade, is quite clear, so that the dark color of the loaf is much less objectionable than it would be if due to the presence of a lower grade of flour. The loaf of the macaroni wheat flour is considerably smaller than that of the standard, but except for the darker color is of good quality.[a]

[a] On this paragraph the writers would remark that the statements concerning gluten content, absorption, and color of the flour certainly could not be made of general application, however true they may be with respect to these particular experiments. Ordinarily the gluten content is higher in the durum wheats when grown in the localities to which they are adapted, and in normal seasons the absorption would be still greater than the difference shown in these experiments. But it is particularly erroneous in general to say that the durum wheat bread or flour is dark. It is simply more creamy in color, as stated in the next paragraph, but would have to be grayish or brown to be considered dark.

By using the macaroni flour in the sponge and the spring wheat patent to complete the dough the loaf was as large as that from the spring wheat patent alone, and in quality was equal to it in all particulars.[a] The bread was a little more creamy in color, which improved the appearance rather than injured it. * * *

Notwithstanding the vigorous opposition which macaroni wheat has developed in certain sections, it is quite apparent at the present time that flour from this wheat will serve a useful purpose in bread making.

In the numerous family bakings, whenever a sponge was made, it was always a particular surprise that such a large loaf could be obtained. There was usually little difference in the size of the loaf and that of bread made from any ordinary good flour.

It will be of interest in this connection to quote the results of a test of this kind of flour made independently by a well-known Minneapolis bakery. In the following statement is quoted a portion of the report of this test, taken from the Minneapolis Journal of September 1, 1903:

August 31, 1903. Dough No. 1, special bread made from pure macaroni wheat flour, should produce 36 loaves; produced 37 loaves. Quantity: 24 pounds macaroni wheat patent flour, ½ pound lard, 6 ounces salt, 3 ounces sugar, 16 pounds water, 4 ounces yeast. Dough made at 6 a. m. Temperature, 84° F. Dough taken 12 m.

Macaroni blend bread. Date, August 31, 1903. Dough No. 2, special blend bread. Quantity: 11 pounds flour, 13 pounds macaroni wheat flour, 8 pounds water for sponge, 8 pounds water for dough, ½ pound lard, 6 ounces salt, 3 ounces sugar, 3 ounces yeast. Sponge set at 6.10 a. m. Temperature, 90° F. Dough made 9.30 a. m. Temperature, 84° F. Dough taken at 12 m.

The foreman of the bakery says, concerning the tests:

I hereby certify that I have made bread out of pure macaroni wheat flour and also out of a blend of one-half macaroni wheat and one-half hard-wheat patent flour, and that I like the macaroni bread very much indeed. The bread is a little more cream colored than hard-wheat bread and looks as though the sponge had been set in milk instead of water, but it is sweeter and more nutritious than ordinary bread.

REMARKS ON THE VARIOUS CHEMICAL AND BAKING TESTS.

The results of the different chemical and baking tests of durum wheat flour for bread in comparison with good hard spring wheat and hard winter wheat seem to justify the following general conclusions concerning the use of durum wheat flour. In general, the least that can be said of the durum wheat flour is that on an average it makes as good bread as the average of hard spring and hard winter wheat flours. It has been seen already in the discussion of the chemical tests of the different flours that there is often very little difference in quality between the durum wheat and the other hard wheat flours. Also, one of the most striking things about the reports on the samples

[a] With the use of a sponge perhaps the pure durum wheat flour would still have made just as large a loaf. (See the second following paragraph.)

of bread distributed in the large baking test is that so often very little difference could be detected between the two kinds of bread. Sometimes even in tasting the bread, if the party were blindfolded he would make a mistake in deciding which was the durum wheat bread and which the ordinary bread. As already stated in preceding pages, probably the chief reason for the similarity of the durum wheat flour and bread to that of ordinary hard wheat in all the different tests made at this time is that the past two seasons in the West and Northwest have been unusually wet, the humidity particularly being unusually great in many localities. As the durum wheat is especially adapted to dry regions, such seasons would, of course, tend to bring it down to a level with the ordinary hard wheat. At the same time there are certain special qualities in which the durum wheat bread is much superior to any other bread. These are as follows:

(1) All the testimony is to the effect that the durum wheat bread is considerably sweeter, when the same amount of sugar is used in the dough, than bread made from other hard wheats. A member of a reliable baking company has informed the writers that if a certain quality of durum wheat could always be obtained practically no sugar would be needed in making bread from it. Even at the low price of sugar this difference would amount to a very large saving in expense where a large output of loaves is made daily.

(2) A majority of the reports shows that the durum wheat flour has a greater absorption than other flours. This difference will mean sometimes an addition of many loaves to the barrel of flour, and, of course, the difference would be very much greater in an average season than it has been during the last two seasons.

(3) From numerous careful observations on the loss of water from the different breads, it is found that the durum wheat bread retains much more moisture for a week or more than bread made from other wheats. Afterwards the daily loss of water appears to be about the same in both kinds of bread. This again is a matter equally as important, probably, as any of the others just mentioned. A loaf of durum wheat bread cut from two to four days after the baking appears practically as fresh as an ordinary loaf of bread cut one day after baking. Such a quality is, of course, of the greatest value in shipping bread or in furnishing bread to the Army or Navy or to others who need often to preserve their bread for some time.

These three qualities are, of course, such as give a distinct financial gain to the baker, while the first and third are desirable to the consumer.

(4) Another important quality in the durum wheat bread, at least for many people, is that with the same amount of baking a much firmer and richer crust is obtained. To many the crust is really the important part of the bread, though there is a considerable difference

in taste in regard to this matter. The crust has a deep rich brown color and a very agreeable flavor.

(5) One would naturally suppose that the most important quality of all would be the actual taste or flavor of the bread, and the evidence from all sides is overwhelmingly in favor of durum wheat bread from this standpoint. The condition is well stated by one of the baking companies already quoted in the statement, "X is the better if you eat with your palate; P, if you taste with your eyes."

(6) While there was no intimation whatever of the nature of the experiment when the loaves were distributed for examination in the cooperative baking test, it is very interesting to note how well a number of parties guessed the kind of wheat from which each of the two loaves was made, though it is also true that in a few cases the guesses were radically wrong. In nearly all cases the supposition was that the durum wheat bread was made from a rather hard wheat flour and the other from flour of a softer wheat. In a number of cases guesses were made that there was more sugar or shortening used in making the durum wheat bread than in the other, which is, of course, accounted for by the fact of the greater amount of sugar and other carbohydrates existing naturally in the durum wheat flour.

THE COLOR OF FLOUR AND BREAD.

It soon becomes evident that the strongest objection made to durum wheat flour is against its color. Opinions from all sides show at once that given the proper color the bread from such flour would meet with universal favor. A thorough study of the situation further shows, however, that the matter of color is a purely relative one and is almost entirely under the control of the baker.

It is evident that a very large part of the secret of success in producing white bread is chiefly in the manipulation of the dough. The mere mechanical operation of thorough separation of the particles of the dough has the effect of adding wonderfully to the whiteness of the bread. It is important to note in this connection that no doubt the reason for the opinion of a number who reported that the loaf P in the cooperative baking test was made from ordinary winter wheat and not hard spring wheat is because of the fact that the dough was mixed in a specially devised mixing machine, which gives an immense amount of mechanical movement and separation of particles of the dough, exposing it thoroughly to the oxygen of the air, and thereby giving a much greater whiteness to the bread than is found in other bread made from the same flour.

There seems no doubt at all now that the dough of durum wheat flour, mixed by modern processes, will make bread with a color entirely satisfactory, while, of course, bread made of a blend of this flour with other kinds would give a still whiter color. At the same time it must be remembered by everyone that no good bread made

to-day from western or northwestern wheat is white, nor is the flour white. The writers take this opportunity to protest decidedly against the language commonly used in and out of print giving the impression that there is such a thing as white flour produced from our best hard wheats. It is a well-known fact that many Minneapolis flours, which may be taken as good standards, are a creamy color, and not white, and that as a matter of fact they at first underwent the greatest of difficulty in becoming established, just on account of the fact that they were not white flours. The durum wheat flour at most produces a bread that is only a little more yellow or creamy than the best hard spring wheat. On the whole, therefore, the objection to the color in the durum wheat flour should no longer be considered a valid one.

This conclusion can be reached independently of any results that may be obtained by the process of bleaching, at present so much discussed in the milling journals.

To the writers there seems at present no valid reason, from a commercial standpoint or otherwise, for the process of bleaching, though it appears to be harmless. In fact, there would seem to be a decided disadvantage in bleaching the certain well-known brands of flours, the people thereby becoming naturally suspicious that there may be some adulteration or something else wrong in the flour. A bread made whiter, however, by simple mechanical manipulation of the dough appears to be improved in other respects also; and if one really wishes to obtain a whiter flour, that would appear to be the better method of obtaining it.

EXPERIENCE REQUIRED FOR PERFECT OPERATIONS.

Coming now to the discussion of an objection on the part of millers to the use of this wheat, which to date appears to be the only legitimate one yet raised, it may be said that it seems to be quite true that in the beginning of operations on the part of any mill it costs considerably more and there is a considerably larger amount of waste in producing the same amount of flour in grinding durum wheat than in handling the hard spring or hard winter wheats. Reports from millers so far indicate that the cost of producing a barrel of durum wheat flour runs from 10 to 15 cents more than that in producing a barrel of ordinary flour, and that 35 to 38 pounds of flour—that is, all products exclusive of shorts and bran—are produced from a bushel of durum wheat, while 40 to 44 pounds may be produced from a bushel of hard spring wheat. At the same time some of these same millers testify that, even on this basis and at this stage of the millers' knowledge of handling the wheat, it is quite profitable to use the durum wheat on account of the much larger yield per acre and the difference in price per bushel. It will be advisable to quote from our correspondence with one of these millers concerning this matter—a Nebraska miller who has now had considerable experience in grind-

ing durum wheat, and who has apparently found it to be a very profitable business. In a letter of February 20, 1904, he says:

> I have mailed you to-day samples of the different grades of flour; also samples of the bran and shorts made from macaroni wheat. The amounts of the different grades are as follows:
>
> Straight patent, 35 pounds per bushel.
> First patent, 18 pounds per bushel.
> Bakers' patent, 15 pounds per bushel.
> Low grade, 2 pounds per bushel.
> Bran, 11 pounds per bushel.
> Shorts, 13 pounds per bushel.
> Loss in grinding, 1 pound per bushel.
>
> The flour has given the best of satisfaction and all who have tried it are highly pleased. In consequence of these tests a large amount of the wheat will be planted this year. I have sold all we had of it at a satisfactory price. It makes less flour per bushel, but being a large yielder it makes up for this loss and leaves it ahead of any other variety as a flour producer when the yield is considered. * * * I am satisfied now that we can make a better showing another year by making a few changes at very little expense which will add to the yield of flour.

In another letter dated March 15, 1904, the same writer says: "As to the cost of grinding this wheat, I have found it cost just one-third more than the other varieties of wheat."

As these are fair samples of statements received in various other letters from millers who have handled the durum wheat, it will be seen that the longer the wheat is handled and the more familiar the miller becomes with it the more flour he is likely to obtain from a bushel of wheat at the same cost. As one's experience grows it is found that certain modifications in machinery can be made which will accomplish much closer grinding. There is no doubt, therefore, that when two or three more years have elapsed the profit in the sale of the flour from a bushel of wheat will very closely approximate that obtained from a bushel of hard spring wheat, particularly when the future increase in the demand and price of the durum wheat flour, which is almost sure to come, is considered. The correspondence of the Department of Agriculture shows that a number of millers who formerly declined to have anything to do with durum wheat are now doing a profitable business in handling it and have already used a comparatively large quantity.

The trials of this wheat for making bread on the part of the bakers and the experiments of various flour experts show also that more and more experience in handling the flour will result in producing better bread. The reader has already noted the change of opinion of the Cleveland baker referred to on a preceding page, who at first thought nothing could be done with the flour, but was finally very much pleased with the results. It will be found nearly always that better success in baking will follow from the use of a regular sponge, particularly if the flour is entirely from durum wheat or if a very large per cent of it is durum wheat flour. More acid is desirable in

producing fermentation than in the use of other flour, and it has even been suggested that possibly a slight amount of commercial acid could be added to advantage; but this, of course, should be considered at present as a matter for experiment.

OTHER PRODUCTS FROM DURUM WHEAT.

The number of breakfast foods already in existence is legion, and it would hardly seem desirable to add to these from other sources. However, people who have used the few breakfast foods that have already been manufactured from durum wheat testify that they are quite distinct from others on the market and are really of excellent quality. As probably only four, five, or a half dozen kinds at most have yet been made from durum wheat, it is evident that here is a field of operations very inviting to the manufacturer and as yet scarcely more than touched. The kinds that have already been made are rather different from each other, and include, to the knowledge of the writers, one product made in Canada and three in this country, one of which is in the form of another well-known breakfast food—that is, the whole wheat rolled into flakes. In flavor these foods are just as superior to those made from ordinary wheat as the flavor of durum wheat bread is superior to that of ordinary bread.

Contrary to the general supposition, excellent biscuits of a certain form can also be made from durum wheat flour. They are comparatively small and with little between the crusts. What are known as "light cakes," made in a manner similar to ordinary bread, are also successfully made from this flour. Perhaps the very best products made from durum wheat flour, however, aside from bread, that are, without any doubt, a complete success, are muffins and pancakes. It can not be questioned that these products are far superior to those made from any other wheat flour. The muffins appear and taste considerably like sweet cake, and the pancakes seem to have more egg in them than similar cakes made from other flour. (See Pl. V.) Certain kinds of sweet cake are ideal when made from durum wheat flour, but of course some other kinds that are intended to be quite white within can not be made from such flour.

PROGRESS OF THE NEW INDUSTRY.

In the nature of things it is of course impossible to obtain statistics of the annual production of a new crop. Up to date, therefore, any reported production of durum wheat has necessarily been simply an estimate. In the experiments of the writers, however, such close watch of the acreage has been kept from year to year that when it finally becomes possible to obtain statistics it will probably be found that the following estimates have been fairly close to the actual production. The first crop of any considerable amount was in 1901, of

which the yield was probably not over 100,000, but close to 60,000 or 70,000 bushels. In 1902 a conservative estimate would place the production at about 1,500,000, although quite likely it reached 2,000,000 bushels. Our estimate of the crop of 1903 was at first 10,000,000 or 12,000,000 bushels. It seems more likely now that it was not much over 6,000,000, but may have reached 7,000,000 bushels. At present it is still more difficult to predict the amount that will be harvested the present season (1904). It can only be said now that it promises to be about 15,000,000 bushels, with the possibility of reaching 20,000,000 bushels. A crop of 20,000,000 bushels would be an increase of at least two hundred fold over the crop of 1901—that is, in four years—and at the same time would constitute one twenty-fifth of the entire wheat crop of the country on the basis of an average annual production of 500,000,000 bushels.

INCREASE IN PRODUCTION OF DURUM WHEAT.

While the yearly increase in the production of this wheat is extraordinary, there is no question that when its commercial value is more fully settled in the minds of those who handle it the demand will be such as to incite a very much greater increase, until finally the annual production will reach its normal proportion to that of other kinds of wheat.

DETERMINATION OF THE BEST VARIETIES.

Of course, as the cultivation of the wheat goes on there are many things to be learned. The necessary experience on the part of the miller and baker has already been referred to, but the farmer also will have to learn which are the best varieties of this wheat. It is known that about a dozen different kinds are now grown throughout the country, some of which differ from each other as much as the varieties of ordinary wheat differ, and it is already known that some of these varieties are considerably better than others, both in the quality of grain furnished and in the yield of the crop. For the Northwest, the bulk of the evidence up to date is in favor of the variety Kubanka. (See Pl. III, fig. 2.) In the Southwest the Kubanka continues to be a very good kind, but two or three of the North African varieties are there among the best. Still, other varieties are under experiment by the Department of Agriculture at a few points, and it has already been found that two or three of these varieties have certain unusually good qualities. It will require several years to determine thoroughly which are the few best varieties for the different portions of the semiarid districts where such wheat is adapted. In the meantime every effort is being used by the Department to encourage the development of pure seed of each one of these varieties and in urging the importance of keeping all durum wheat absolutely separate from other kinds. Whether dealing with this wheat or any

other kind of grain, the most important thing of all is to keep up a constant improvement of seed.

COMMERCIAL INSPECTION AND GRADING.

Much has yet to be learned by commercial men of the actual qualities of the wheat, which will enable them more accurately to inspect and grade the grain. This wheat, being so different from other kinds, will require that a different standard be kept in view all the time in the work of inspection. Certain new qualities will have to be added to the regular schedule or score cards. Also, as the wheat may be used either for bread or for macaroni, it must be considered each time whether it is to be used for the one purpose or the other. For example, during the seasons of 1902 and 1903, which throughout the country generally were unusually bad for producing a really excellent quality of durum wheat, the softer and whiter condition of the grain made it, nevertheless, really better for handling by the millers for making bread flour, but at the same time the wheat was less suitable for use in making the best macaroni.

DISPOSITION OF THE 1903 CROP.

Through considerable correspondence and personal investigation the writers are able to state approximately the disposition of the last year's crop, though of course no one could expect accuracy in the matter. On the basis of a crop of 6,000,000 bushels, it appears that the disposition up to March 1, 1904, was about as follows: On the authority of Mr. J. N. Barncard, chief deputy inspector for Minneapolis, there were inspected when going into that city from September 1, 1903, up to and including February 29, 1904, 832 cars, which, at an average of 1,000 bushels per car, would make 832,000 bushels. During the same period there were inspected 317 outgoing cars, or 317,000 bushels. It may be added that for the crop year of 1902–3, ending August 31, 1903, there were inspected when going into Minneapolis 187 cars, or 187,000 bushels.

It is reported by a well-informed broker on the New York Produce Exchange that up to March 4, 1904, and since August of the preceding year there were exported from New York something over 340,000 bushels. At the same time it is known that from 50,000 to 100,000 bushels were sold for different purposes in Boston and other portions of New England; but these figures only apply as far as the month of March, 1904. Therefore, the entire amount of the wheat of the 1903 crop sold in Minneapolis and the lake cities, exported to foreign countries, and used for various purposes in the Eastern States would probably come close to 1,500,000 bushels. Allowing another million bushels for seed, for feeding to stock, for breakfast foods, and other miscellaneous purposes, there remain probably at least three and one-half

million bushels that have been ground at the local mills for bread flour and for the production of macaroni, much the larger part of which was used for bread.

MILLS NOW HANDLING THE WHEAT.

The number of mills that have undertaken the grinding of the new wheat is constantly increasing. Several large mills that have not hitherto used this wheat and that in some cases have strongly objected to the use of the wheat are to be added to the list for the coming season. The increase in the demand for the wheat has been particularly strong in Buffalo and a few other points in the East, originating solely in the desire to use the flour for blending with other kinds in bread making. By the autumn of 1904, there will no doubt be at least twenty-five important mills throughout the country using durum wheat.

PRICES.

Durum wheat being so different in nature from all other kinds, it should not be expected that prices would range in a series parallel with those of other wheats. At a time of special demand for it the price may rise proportionally more rapidly than for other kinds, but often it may remain stationary or fall when the price of other wheat is rising. However, the general scarcity of wheat throughout the country, which has at the same time forced more attention to durum wheat, and therefore caused its good qualities to be better known, has been the means of securing good prices for the wheat during all the latter part of the past winter and up to the present time, the price having ranged from 90 cents to about $1.05 per bushel at Buffalo, N. Y. One difficulty in the past, which will no doubt soon be overcome, has been that the bakers were slow at first to make use of the flour, because of the fact that the difficulties at first met by the millers in handling the wheat have not allowed them to sell the flour at an attractive figure to the baker. No doubt, as soon as the milling operations for this wheat are more accurately adjusted the miller will be able to get a better profit and can offer the flour at more attractive prices, and this apparently is all that is needed, for, as stated elsewhere, all trials of the flour by bakers so far known to the writers have given most excellent results.

THE OUTLOOK.

A prediction of the probable crop of 1904 has been made. Fifteen or twenty million bushels of a wheat which does not encroach upon the regular production of other kinds is a large quantity to be added to the general production of this country; but it should be noted that this leaves out of consideration entirely the enormous areas of the

semiarid and even arid districts admirably adapted to this grain which have not yet been touched by agriculture. The possibilities in reach of the farmers and commercial men in the production and trade in this new grain are not suspected at present by the people in general. Even under irrigation the wheat succeeds very well, but over by far the larger portions of the dry districts irrigation will be unnecessary, which can only be said, however, of a very few drought-resistant crops. All the while new districts of production are being developed and new trade centers established, as well as new trade routes. This wheat will be sold during the coming year at Kansas City, Omaha, and Galveston, as well as at Minneapolis and Duluth, and there will be a very large increase over last year in the production of durum wheat in the districts tributary to these points, the production last year, in fact, being insignificant.

Aside from the export outlet for durum wheat, either in the form of the wheat itself or as semolina in France and Italy for the production of macaroni, there are, without question, still other outlets at present not at all considered by grain dealers or millers.[a] In a number of foreign countries where bread of a rich flavor is desired without regard to color durum wheat flour will be very popular. This, no doubt, will be particularly true in those districts of the Far East where there has been unusually rapid development in recent years. The increase in wheat production in Manchuria and the very large increase in flour production in the same country, instead of injuring our flour trade in the Orient, may, by educating the native population to the use of wheat bread, so increase the demand for such a product as to really benefit the trade of this country. Present conditions seem to indicate that this is quite likely to be the correct view. Should the Chinese and Japanese and other oriental peoples become fully acquainted with the use of wheat bread, the export outlet for American flour, and particularly for flour made from this class of wheat, would be, at least for a time, practically unlimited. It would seem, therefore, to be greatly to the interest of the millers and grain dealers to give special attention to the encouragement of the production of durum wheat in all of our undeveloped semiarid areas. It is evident now that its increase in production is of just as great importance to millers and shippers as it is to the farmer.

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[a] It is quite erroneous to assume that there is little export demand for durum wheat because of the numerous negative replies given in recent Daily Consular Reports in the investigation of this matter by the Department of Commerce and Labor. These replies were from points where a market for this wheat, or in some cases for any other wheat, should not be expected.

DESCRIPTION OF PLATES.

PLATE I. *Frontispiece.*—A representation of two loaves of bread, one of which was made from durum wheat patent flour and the other from the best quality of northwestern hard spring wheat patent at the same time, by the same bakery, under the same conditions, the same kinds and proportional amounts of ingredients other than flour being used in each case. These are only samples of scores of loaves that presented the same appearance, showing that the least that can be said is that usually the durum wheat bread can scarcely be distinguished from bread of other first-class flour when baked by accurate methods, so far as mere appearance goes, while from the standpoint of flavor, freshness, and texture very many people really prefer the durum wheat bread.

PLATE II. Samples of three varieties of durum wheat. These are representative samples of this class of wheat as it appears when grown in North and South Dakota.

PLATE III. Fig. 1.—Harvesting durum wheat in North Dakota. Fifteen self-binders are shown on the farm of Mr. S. Glover, at Glover, N. Dak., in 1903. There were 6,000 acres of durum wheat grown on this farm in that season, producing about 100,000 bushels of grain. A considerable amount of this was of the Kubanka variety, but the larger part was of the variety Arnautka, the kind most largely grown in the Northwest. Fig. 2.—Kubanka durum wheat growing in western Kansas in 1903. The cultivation of durum wheat in western Kansas has only begun very recently. This picture shows the character of the crop during a wet and therefore unfavorable season.

PLATE IV. Fig. 1.—Freshly cut durum and spring wheat bread side by side. The bread is of the same baking as that illustrated in the frontispiece. The loaf on the right was made from durum wheat patent flour and the other from the best quality of northwestern spring wheat patent. The difference in texture is rather clearly shown, and to a slight degree the difference in color, though the latter is somewhat misleading, as a yellow color can not be shown in a photograph. Fig. 2.—Two loaves each of durum and spring wheat bread—a later baking. The two loaves on the right were baked from durum wheat patent flour and the two on the left from the best quality of northwestern spring wheat patent. In this case the durum wheat flour is of an entirely different lot from that used in the first baking and was really of much better quality, the loaves being as satisfactory in size, lightness, and color as anyone could wish, while the flavor and texture were considered by nearly everyone to be much better than that of standard spring wheat bread.

PLATE V. Muffins made from durum wheat patent flour. These muffins were so radically different from those made of standard spring wheat flour and so much superior in flavor and texture as to really form a distinct and unique product. The picture shows very clearly their appearance and at the same time the class of wheat from which the muffins were made.

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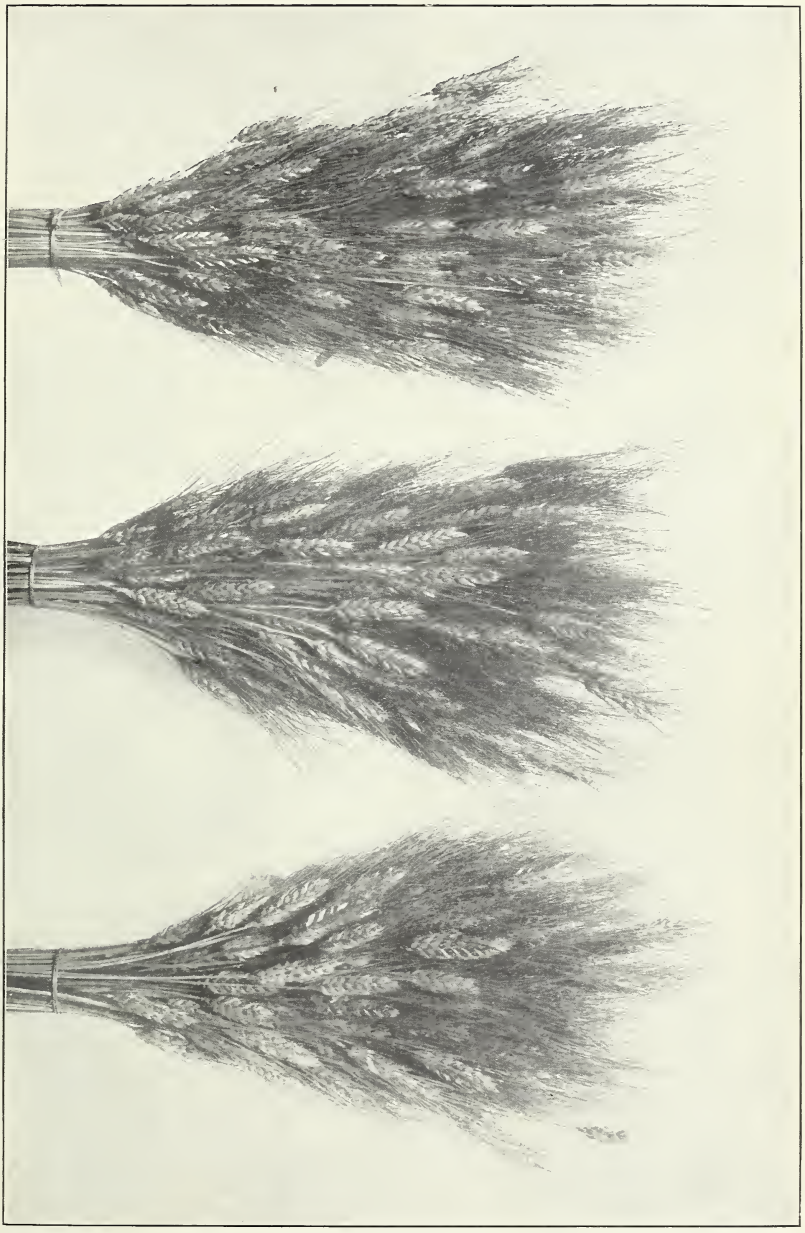


SAMPLES OF THREE VARIETIES OF DURUM WHEAT.

FIG. 1.—HARVESTING DURUM WHEAT IN NORTH DAKOTA.

FIG. 2.—KUBANKA DURUM WHEAT GROWING IN WESTERN KANSAS IN 1903.

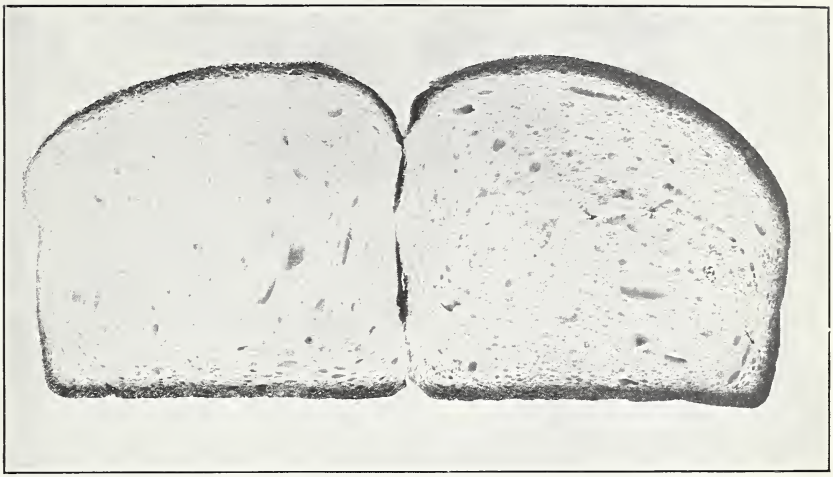
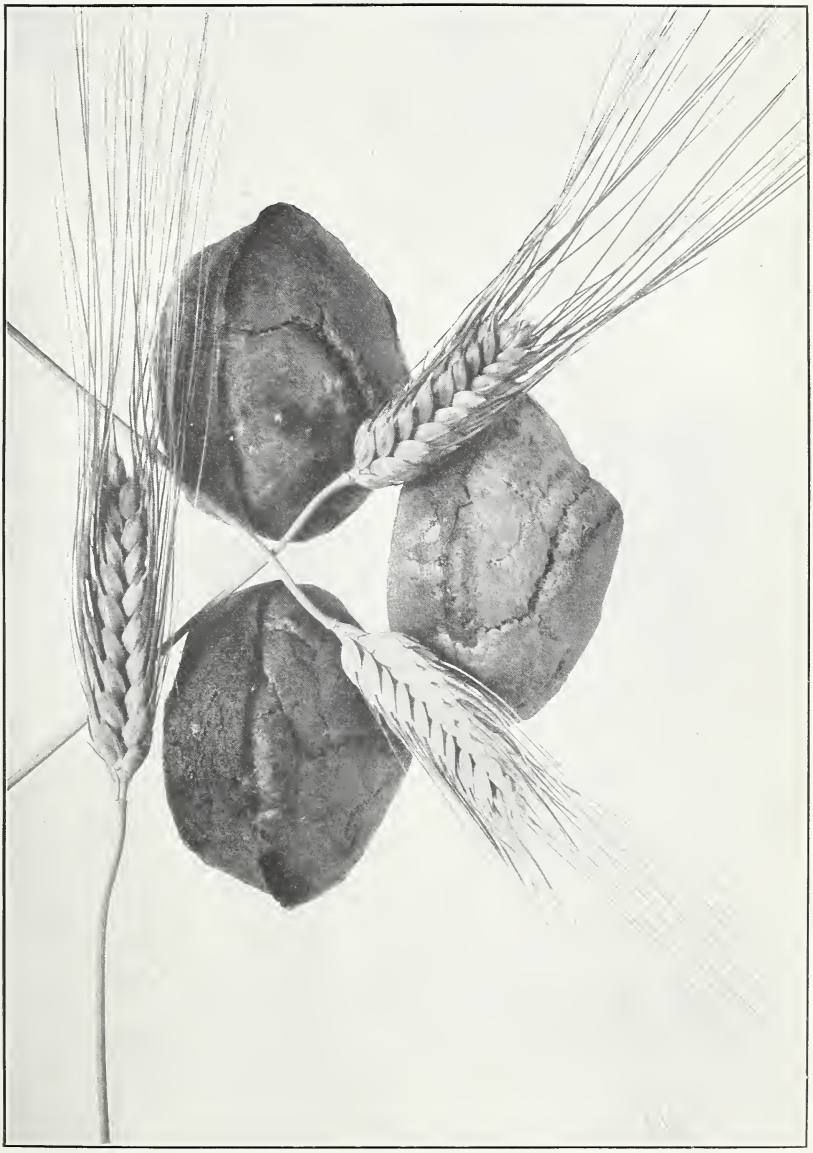


FIG. 1.—FRESHLY CUT DURUM AND SPRING WHEAT BREAD SIDE BY SIDE.

FIG. 2.—TWO LOAVES EACH OF DURUM AND SPRING WHEAT BREAD—A LATER BAKING.



MUFFINS MADE FROM DURUM WHEAT PATENT FLOUR.